The Mining Magazine

PUBLISHED AT SALISBURY HOUSE, LONDON.

INDEX TO VOLUME XXI.

FROM JULY TO DECEMBER, 1919.

EXPLANATORY NOTE.—Items in italics are names of books reviewed; illustrated articles are denoted by asterisks (*); the letters (*m.d.*) refer to notices of articles under the heading "Mining Digest."

The Mining Magazine

W. F. WHITE, *Managing Director*. EDWARD WALKER, M.SC., F.G.S., *Editor*.

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938*. Telegraphic Address: *Oligoclase*. Codes: *McNeill*, both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION: U.K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XXI. No. 1. LONDON, JULY, 1919. PRICE ONE SHILLING

CONTENTS.

EDITORIAL

A SECOND exhibition under the auspices of the British Science Guild was opened the other day at the Central Hall, Westminster. It is well worth a visit, and should be supported by all who take an interest in the application of science to industry.

THE new Elmore process for separating mixed sulphides consists of treating the ore or concentrate with hot strong sulphuric acid, which converts the galena into sulphate, but has no substantial effect on the blende. The sulphate of lead is dissolved by means of hot concentrated brine.

PEACE has been signed and a contract made by the English-speaking countries to come to the aid of France when wantonly attacked. In certain circles among mining engineers in this country there is a disposition to jeer at the League of Nations and President Wilson, and an inclination to prophesy acute friction between England and the United States before many years have passed. To such unbelievers in the principle of good-will we would say that one way to ensure the arrival of a disaster is to prophesy it publicly often enough. In the present case we know of no other reason for expecting the failure of the League or trouble between England and America than this form of prophetic wisdom.

IN this issue is published the first part of an article by Mr. David Penman on Modern Rock-Drill Practice. The article is not intended for either the makers or every-day users of rock-drills, but rather for the general reader interested in mining. Of recent years many improvements have been introduced in rock-drills, among which the use of the hammer action, the automatic keeping of the drill to its work, and the introduction of water to avoid the creation of dust are the most important. The descriptions of these improvements have usually been confined to strictly technical articles or to trade announcements, and the average reader who is not a specialist has not had full opportunity of grasping their significance. Mr. Penman's brief review gives the information desired by such readers. In preparing an article of this character, it is difficult to present the matter in such a way as to please all makers, and an author is sometimes accused of having a particular axe to grind. Mr. Penman is, however, quite impartial, and his choice of typical machines for description does not necessarily imply any expression of opinion of relative merits.

CONGRATULATIONS to Mr. S. J. Truscott on his appointment as Professor of Mining at the Royal School of Mines. Mr. Truscott has held the position of Assistant-Professor for the past seven years, and in both the lecture room and the research laboratory has proved his efficiency and enterprise. He took his A.R.S.M. in 1889, the De la Beche Medal in the same year, and the Murchison Prize in 1888. His professional experience has been gained on the Rand, and in the Dutch East Indies, West Africa, and the Urals. His book "The Witwatersrand Goldfields" is a standard authority, and his translation of Beyschlag, Krusch, and Vogt's "Ore Deposits" is winning a similar reputation.

SPITSBERGEN loomed large in the advertisement columns of *The Times* and the financial papers on June 27, where the speech of the chairman of the Northern Exploration Company was reported at great length. A different story is told by two Norwegian engineers elsewhere in this issue. The chairman took care to discount this class of evidence, by alleging that German influence in Norway is strong and that it is being used to belittle the doings of his company. The weak point of the chairman's case is that he produces no evidence of equal class to that of the eminent geologists quoted in our pages. When he can produce a favourable report from a leading British specialist on iron ore deposits, we shall begin to take notice.

THE Supreme Court of the United States has delivered its supplementary judgment in connection with the interpretation of Minerals Separation patent 835,120, applied for on May 29, 1905, claiming the use of a fraction of 1% of oil for the making of a froth by agitation. In the proceedings against James M. Hyde, Minerals Separation won its case, but subsequently it had to commence a second action, because Butte & Superior sought to evade the patent by adding more than 1% of oil. Judge Bourquin, in the Montana court, held that the use of more than 1% was an infringement, because Butte & Superior added cheap petroleum to the effective pine oil for the sole object of bringing the total over 1% and so evading the patent. The Circuit Court of Appeals reversed this judgment, and introduced a new definition of "a fraction of 1%," holding that "a fraction" meant less than $\frac{1}{2}$%. The Supreme Court has restored the meaning of "a fraction" to "anything less than 1%," but sustains the Court of Appeal in its view that the use of any frothing oil or mixture of frothing oils, efficient frothers or not, exceeding in amount 1% evades the patent. The case is now remitted to Judge Bourquin for him to assess the amount due to Minerals Separation for use of the process before the total oil was raised to over 1%. Presumably Butte & Superior will continue to add cheap petroleum, which is a comparatively poor frother, to the pine oil, and to obtain a lower recovery, in order to avoid paying royalties to Minerals Separation.

MINING engineers in training in this country have little or no opportunity of studying the problems involved in the treatment of alluvial deposits. It is to be hoped that when the Camborne Mining School is expanded, or when this school and the Royal School of Mines are amalgamated or affiliated, a practical course in alluvial mining will be established. There are many places in Cornwall where such operations can be studied. The degree of insight into the various methods of bringing the alluvium to the sluices would depend on the commercial installations in operation, but examination of the sluicing characteristics of the deposits and the testing of gravels by drilling could always be conducted. It might be that the work done by the schools would prove of value to the community if it disclosed profitable deposits.

NO user of coal can accept the ill-considered proposals contained in the various reports on nationalization issued by the respective sections of the Coal Commission. These sections appear mostly to have placed on paper the views which they have often expressed before and since the Commission was appointed. Mr. Justice Sankey issued the only unbiassed report. He enunciated a scheme for working the mines by means of machinery similar to the Joint Industrial Councils. Naturally, knowing nothing of technical matters, his opinion could only be based on the exigencies of political and labour problems. For this reason his recommendations are quite superficial and offer no suggestions that will help in improvements in the mining and use of coal; while, on the other hand, he did not please the working miner because he attempted to impose restrictions on the inalienable right to strike. It is not necessary to discuss the miners' proposal to override the statute of limitations and rob the royalty-owners without compensation. That is not the basis of English justice or business principles. Nor need we examine closely the proposal of the miners and the socialists to operate the mines for the benefit of the worker, except to say that if the miner thinks only of himself in his relation to the employer he at the same time plays false to his fellow worker in the trades and manufactures that depend on cheap and plentiful coal. The only way for a worker to place himself in a comfortable position and to provide opportunities of profitable employment to others of his class is to be continuously diligent and to take a pride in his efficiency and and quickness. Users of coal are naturally alarmed at the prospect of continuous rises in price and decreases in delivery, and every effort must be exerted to prevent the Government from plunging the country's manufactures into the quagmire. The only recommendation in the whole of the reports that will be received by economists with satisfaction is that dealing with the nationalization of royalties. Under the proposed system it will be possible to improve the methods of mining and distribution of coal, and to inaugurate comprehensive schemes of generating power at the pit's mouth involving electrification and recovery of by-products of gas manufacture. It will also tend to remove the old abuse of gutting the properties by working only the best seams and thereby ruining the others.

A Register of Mining Engineers.

In his valedictory address at the annual meeting of the Institution of Mining and Metallurgy held in May, the retiring president, Mr. Hugh F. Marriott, referred very briefly to a matter now before the council, namely, the preparation of a register of qualified mining engineers. Some years ago it was the hope of certain reformers to make the membership of the Institution the test of efficiency and reliability, and they even went so far as to suggest that no one should be allowed to call himself a mining engineer concerned in non-ferrous mining and metallurgy, unless he had the qualification of membership. In theory this ambition was laudable enough, but the means of judgment as to suitability of membership was, and still is, on too narrow a basis for the responsibility of one society. There are so many ways of becoming dependable mining


TEHIDY MINERALS.
Indicates shares of ownerships of mineral rights
Scale of Miles
REDRUTH
CAMBORNE
PORTREATH
ILLOGAN
TROON
PENPONDS
GWITHIAN
GWINEAR
Wheal Peevor
West Lushington
W Tolgus
Tolgus
N. Pool
East Pool & Agar
Tincroft
Basser
South Francis
Grenville
Condurrow
N. Crofty
S. Crofty
East Seton
Emily Henrietta
Wheat Seton
West Seton
Dolcoath
New Seton
South Seton
Grand Bojena
Violet Seton
Rosedown
W. Boskear
Portobello
Tehidy House
Godrevy Point
Pool lode
North lode
Rogers lode
South lode
Dolcoath main lode

engineers, and mining engineering has so many ramifications and interdependencies, that some latitude as to membership of societies is necessary. To illustrate our meaning, we would say that many men who belong to no other society than the Iron and Steel Institute would be excellent judges of the value and nature of the iron ore deposits at Spitsbergen. It would appear therefore to be politic for the four societies to undertake the responsibility conjointly. These societies, the Institution of Mining and Metallurgy, the Institution of Mining Engineers, the Iron and Steel Institute, and the Institute of Metals, have already taken joint action in connection with the establishment of the Imperial Mineral Resources Bureau, and a similar course is appropriate in connection with the registration of mining engineers.

The public has still to be protected from the quack in mining, though the Treasury control of new issues has tended of late to prevent glaring cases of fraud and incompetence. The proverbial ex-tinker is only hibernating, and will awake when his time comes. It is well, therefore, to be prepared for his renewal of activities. It would be fortunate if the four societies could be empowered to do more than prepare a register of competent engineers, for as a rule the victims are people who would not be aware of the existence of a register, any more than they are aware of the existence of the restraining influence of such papers as this Magazine and *The Financial Times*. When an objectionable prospectus or similar invitation to subscribe for shares is circulated publicly or privately, those responsible for the register should have active as well as passive duties, and should have the power to take steps to suppress a scandal. It is not necessary for us to say more, for readers are well aware of our desire to place mining on a respectable footing. The new step indicated by Mr. Marriott has our entire approval.

Tehidy Minerals.

Readers will remember that a year or more ago the controllers of Dolcoath and East Pool combined to purchase the mineral rights of the Tehidy Estate, in the Camborne district of Cornwall, an estate that had been in the Basset family since the days of William the Conqueror. The two companies retained for themselves the rights to the ground they have worked for many years, and also of adjoining properties that can be conveniently worked in conjunction. The remainder of the mining rights were handed over to a company called Tehidy Minerals, Limited, formed early this year. Of the capital (£100,000) £40,000 belongs to Dolcoath and £20,000 to East Pool, while £40,000 was subscribed publicly. Messrs. Bewick, Moreing & Co., general managers of East Pool, and Mr. R. Arthur Thomas, managing director of Dolcoath, were appointed consulting engineers to the new company. But long before the company was formed, the work of investigating the geology of the district was undertaken by members of the staff of Messrs. Bewick, Moreing & Co., namely, Dr. Malcolm Maclaren and Mr. W. A. Macleod. At the statutory meeting of the new company held last month, Mr. C. A. Moreing gave some particulars of the exploratory work, and exhibited on the wall a number of elaborate plans and sections of the rock-formations, lodes, and workings, which have been compiled by the researches and deductions of Messrs. Maclaren and Macleod. He also showed a map of the estate. We give herewith a generalized condensation of this map, from which it will be seen that the estate extends from Gwithian sands on the west to Porthtowan on the east. The horizontal hatching indicates the parts of the estate where the company owns the whole of the mineral rights, either from the surface downward or below a depth of 15 fathoms; while the vertical hatching represents parts of the estate where the company owns varying shares of the mineral rights. The topography shows the position of Dolcoath and of East Pool, together with the Tolgus properties, which are being developed by the latter. In between, the position of South Crofty is indicated. As regards the tracts where the company has the entire rights from the surface downward, these are confined chiefly to the line of the Red River and to the Gwithian sands at its mouth. It is probable that the company will associate itself with the company owning the lease of Gwithian sands for the purpose of inaugurating a comprehensive dredging campaign, and that it will undertake similar work on the river itself. As regards prospective lode-mining, the intention is to attack the deep levels of the lodes to the north of the present line of workings between Camborne and Redruth. In earlier times properties such as the Seton have yielded copper ores from the killas, otherwise slates, and there is every reason to believe that where the lodes enter the granite workable tin ore will be found. These northern lodes, however, enter the granite at too great a depth for the older mining operators, but with modern improvements in methods this fact should present no difficulty.

Mr. Moreing's system does not involve any reopening of old shafts or the unwatering of old workings. His plan, as demonstrated at the Tolgus, is to prospect laterally at depth by means of cross-cut and bore-hole. British metalliferous mining has never before been the subject of so comprehensive a scheme of examination and development as is proposed by Tehidy Minerals, and Cornwall should reap great advantage from the campaign.

Goodchild on Ore Deposits.

Last month's meeting of the Institution of Mining and Metallurgy was devoted to a discussion of the theory of igneous ore deposits, which was propounded by Mr. W. H. Goodchild in his articles published in this Magazine last year. The subject was introduced by means of a paper containing a brief summary of the subject matter of the articles, and by a short verbal opening by the author. The fact that the theory should be discussed in this way speaks much for the general recognition of its importance, and the quality of the discussion and the personality of the speakers goes to confirm this impression. We feel ourselves arrided, as *The Times* dramatic critic used to say, that articles in this Magazine should be discussed at a meeting of the Institution, and we thank the Council for the compliment implied. We also pat ourselves on the back for having recognized the importance of Mr. Goodchild's theory, and for having encouraged him to write the articles.

Of the various speakers at the meeting, Mr. R. D. Oldham was perhaps the most interesting, for he extended the application of the principle of volume changes to physical geology. Mr. Goodchild himself was not unaware of this application, but when he wrote the articles we had, owing to the exigencies of space, to advise him to confine the discussion to the genesis of ore deposits and not to tackle the general history of the earth. Mr. Oldham is one of our foremost physical geologists, and he admitted that in his studies there were several problems without solution until Mr. Goodchild propounded his theory. Faulting, elevation of mountain ranges, and the "sudden-origin" earthquake are now all explained by change of volume.

That distinguished doyen of petrologists, Sir Jethro Teall, in complimenting Mr. Goodchild on his work, made the announcement that the founding of an institute for the study of the origin of minerals is being favourably considered by the Committee for Scientific and Industrial Research. Such an institute would be able to obtain evidence of the behaviour of minerals under high pressure, evidence which Mr. Goodchild has naturally been unable to secure. Another distinguished petrologist, Dr. J. W. Evans, mentioned that Mr. Goodchild's arguments directly controverted the opinion recently expressed in America that pressure had little to do with the formation of minerals. For this reason, if for no other, he said, it would be well if independent investigations were made in this country, instead of depending as heretofore on the researches of the American institutions. Dr. Evans differed in one detail from Mr Goodchild. He thought 2% of water in a magma to be far too little to produce the results described, and he proposed 20% instead. For ourselves we think that with Dr. Evans's figure no land surface would ever have been formed on the globe. Dr. J. V. Elsden also discussed the paper in thoroughly competent fashion, though perhaps he has not fully appreciated the significance of density analyses of minerals.

Of the speakers on the mining engineering side, Mr. E. T. McCarthy made the most appreciative speech. Mr. H. F. Marriott and Mr. H. F. Collins were a little sceptical and cold as to the practical value of the author's speculations on the origin of ore deposits. The pessimist of the evening, however, was Dr. Willet G. Miller. The only congratulation he extended to Mr. Goodchild was based on the omission of the name Sudbury from the paper. This showed that Dr. Miller had not read the original articles in the Magazine, for the discussion of the application of the theory to the Sudbury deposits gave the quietus to the two conflicting schools that have maintained so animated a controversy for years. Dr. Miller, was, unfortunately, right when he said that controversies on the origin of ore deposits arouse bitter feelings and professional jealousies. We may put this another way, and say that the greatest tragedy in the life of a young economic geologist is his discovery of field evidence which upsets his principal's pet theory. The other geologist from Canada contributing to the discussion, Major R. W. Brock, was not quite so dismal as Dr. Miller, but he did not appear to think that the theory was of more than scientific interest.

It is not desirable for us to report the discussion in full detail on the present occasion, for further discussion will come forward in writing, and Mr. Goodchild will reply. On a later occasion we shall publish a supplementary article embodying the new arguments and opinions adduced in the discussion.

REVIEW OF MINING

Introduction.—The signing of Peace, and the conquest of the Atlantic by aeroplane and air-ship are the favourable events of the month. On the other hand, the labour unrest in this country is an evil omen, and the continued rise in the price of coal is giving manufacturers great disquietude. Mining and the metal market are still overshadowed by the vast Government stocks of metal. There appears to be little hope now that gold mining will receive national support in any part of the world; any benefits to be obtained will depend merely on methods of marketing.

Transvaal.—The Government still stands aloof in the matter of helping low-grade mines, and the Rand houses in vain draw attention to the critical financial position of many of the operating companies. Conditions might be improved if labour was more plentiful, but permission to resume recruiting from north of latitude 22°S, the most likely source of additional natives, is refused. The labour shortage was clearly indicated by Sir Lionel Phillips at the meeting of shareholders of the Central Mining and Investment Corporation when he said that the plants were able to work during 1918 at 71% capacity, and during 1917 at 81%, as against a normal of about 92%.

The Transvaal mines are expecting another burden in the shape of additional contributions to the Phthisis Fund for retrospective payment to sufferers and dependents of past sufferers. If the bill passes into law, probably the mines will have to pay £2,000,000.

A serious fall of hanging wall occurred at the Durban Roodepoort Deep on June 23, in No. 1 shaft, between the 7th and 11th levels. It will take a month to repair the shaft.

The Aurora West reports a serious accident at the mill engines, and until repairs are completed it will not be possible to run more than 45 out of the 80 stamps. The June and July figures of output will be affected.

It is announced that the bores on Eendracht, Boschoek, and Town Lands in the Heidelberg district have been suddenly stopped before they had been sunk far enough to intersect the reef according to orthodox views of the geology. Mr. Bleloch's theory is that the Van Ryn reef is nearer the surface than the orthodox geologists hold. The position is not clear at present.

Diamonds.—Reports are to hand that a diamond deposit has been found in the Rouxville district, Orange Free State. The discovery was made in the course of digging an irrigation trench. The stones are said to be plentiful and of good quality, the largest weighing 50 carats.

Rhodesia.—The output of gold during May was £218,057, as compared with £213,160 in April, and £239,205 in May, 1918. The end of the Eldorado mine is reflected in the May return of £5,770 as compared with £10,233 in April. Other outputs for May were: Silver 17,587 oz., copper 297 tons, chrome ore 4,890 tons, asbestos 832 tons, arsenic 13 tons, coal 45,759 tons, and diamonds 30 carats.

The British South Africa Company is about to close its mining department, probably at the end of the current year. The company's chief engineer, Mr. A. H. Ackermann, has already resigned, and, as recorded in the Personal column, has gone to Transylvania. He held the position for thirteen years, having succeeded Mr. E. H. Garthwaite in 1906.

The mines of the Selukwe Columbia company have recently been let on tribute, but are not now yielding profit to anybody, so the whole property of the company is to be sold and the company wound up.

The Planet Arcturus company reports that its chief properties, the Slate and Arcturus, have been put in order by the Gold Fields Rhodesian Development Co., and that the mill will be ready to start at the end of this year.

West Africa.—The output of gold during May was £100,827 as compared with £109,570 in April and £126,290 in May, 1918. The Ashanti Goldfields reported a figure lower than normal, due to an accident at the shaft which caused hoisting to be suspended for four days.

Australasia.—During the last few years the Mount Boppy gold mine has suffered from alternate drought and flood. No rain worth mentioning has fallen since January, 1918, and the campaign on the ore around the old main shaft, which began in February, came to an end in November for lack of water. In March the drought was broken, but the mine did not benefit as much as some districts in New South Wales, and resumption of operations was only temporary. This dislocation has put the company in financial straits, and further funds are to be raised by reconstruction. The preference shares are to be reduced from £1 to 10s., and three new 10s. ordinary shares, credited 7s. 6d. paid, are to be offered to the holders of two £1 shares. In this way £22,687 of fresh capital will be provided if all the shares are taken up. The ore reserve is calculated at 188,158 tons averaging 5 dwt., and in addition there is a large amount of low-grade oxidized ore that can be worked by open-cut.

We recorded some time ago that the Mungana company near Chillagoe, Queensland, had been put into liquidation owing to the impossibility of continuing operations after the closing of the Chillagoe smelter. Now that the Government has purchased the Chillagoe property and is re-opening the smelter, the Mungana mines are to be reopened. A new company has been formed to acquire the properties from the liquidator, to be called the Mungana Silver-Lead Mines Co., having a capital of £100,000. Half of the shares will be paid as purchase price and the remainder will be sold for cash, and will thus provide £50,000 working capital. The two mines, the Girofla and Lady Jane, are full of water, the latter having been flooded to extinguish a fire. The first work to be undertaken will be the unwatering of the workings, which is expected to cost £10,000. The ore reserves in sight in the Lady Jane are stated to be estimated at 50,000 tons, containing 27% lead, 10 oz. silver, and 3% copper; while the Girofla is estimated to contain 107,000 tons ore, averaging 10 oz. silver, and 5% copper. During the years 1906, 1907, 1909, and 1911 the old Mungana company made a profit of over £90,000. In addition to increased facilities generally expected from the taking over by the Government of the Chillagoe smelter and the Chillagoe and Etheridge railways, it is expected that coke for smelting will be now available from the Mt. Mulligan mine, at a cost of 35s. a ton, compared with £4 a ton, the cost previously ruling at the smelters.

The transfer of the Chillagoe mines, smelter, and railway to the Queensland Government has at last been effected. The company's sole remaining asset is the Mount Mulligan coal deposit. As mentioned in the preceding paragraph, coke ovens are to be erected. A satisfactory business in both coal and coke is anticipated.

Labour troubles at Australian mines continue. The strike at Broken Hill is not yet settled, and now Kalgoorlie is threatened with a suspension of operations owing to the woodcutters demanding an impossible advance in the rate of pay.

The labour position at Mount Morgan has improved. After operations had been suspended for a fortnight from June 14, the Unions agreed to allow blister copper to be transported to the Port Kembla refinery. The directors thereupon decided to resume work at the mine.

The Commonwealth Government has requested Mr. A. A. Boyd, general manager of the Mount Morgan mine, to report on the Blythe River iron ore deposits in northern Tasmania, particulars of which we gave in the March issue. Mr. Boyd will be assisted by Mr. C. G. Gibson, geologist, and Mr. G. W. Young, mining surveyor.

At the South Blocks mine at Broken Hill, worked by the Zinc Corporation, the lead lode continues to develop well. On the other hand, the parallel zinc lode is not up to expectations, and in depth the profitable blende occurs only in irregular lenses. When the mine was bought, it was expected that the zinc lode would provide material suitable for treatment in the concentration plant employed on the zinc tailing dumps, for the treatment of which the corporation was originally formed, when these dumps are exhausted. The lode is failing to support these expectations, but the lead lode is more than making up for it. The corporation has recently taken a ⅗ths share in the Australian patents right of the new Elmore process and is proceeding to erect an experimental plant. The Amalgamated Zinc (De Bavay's) has adopted a similar policy in connection with the Ganelin, or chloride, process.

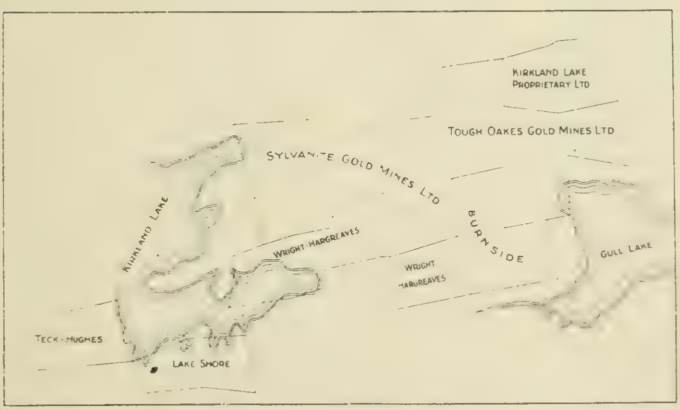
Malaya.—The report of the Tekka company for the year ended January 31 shows increases in the output and profit. The amount of ground treated was 487,950 cubic yards, and the output of tin concentrate 510 tons. The profit was £72,166, out of which £34,000 has been distributed as dividend, being at the rate of 42½%. Extra cost has been incurred recently owing to the falling of ground and the consequent necessity of moving the pipe-line. The current output is rather less than during 1918, but is sufficient to maintain the rate of dividend. A large balance was kept in hand at the end of 1918 to provide for Excess Profits Duty.

The Pahang Corporation announces the cutting of the Willink's lode on the 900 ft. level. The lode at the point of intersection is 5 ft. wide and assays 1·5% metallic tin per ton.

Cornwall.— The new treatment plant at the Geevor mine, which will double the monthly capacity from 2,000 to 4,000 tons and the output of concentrate from 30 to 60 tons, will be completed shortly. Mr. John M. Iles has paid another visit to the property, and has made a brief report, in which he expresses gratification with the results of development and of the prospects for still further increasing the ore reserves. He is of opinion that within a short time it will be possible to mine 8,000 tons per month, so that a further expansion of the treatment plant may be considered.

British Mining.—The Government promised an inquiry into the state of the non-ferrous metal industry in this country, but has shown no inclination to take prompt steps to relieve the financial stress caused by the fall in prices of the metals, higher statutory wages, and the increased cost of fuel. Our Cornish correspondent announces that the only benefit offered is the loan of money something below the break-up value of the machinery. A specific case of the doubtful future of lead and zinc mining is provided by Mr. John Mitchell, who writes in this issue on the Wanlockhead and Leadhills district in South Scotland. These fine old mines have plenty of life left in them, provided the temporary adverse conditions can be weathered. The driving of the drainage tunnel advocated by Mr. Mitchell is a thoroughly sound proposal, and it would undoubtedly make available large reserves of ore. If the mines were in the Dominions, part of the cost of the tunnel would be readily shouldered by the Government. It is not too late for the home authorities to take the same interest in non-ferrous metal mining.

Canada.—We publish elsewhere in this issue a short article by Col. H. H. Johnson on the present conditions at the Kirkland Lake goldfield. He was sent out recently to advise as to the policy of the Kirkland Lake Proprietary in connection with a proposed amalgamation with the Tough-Oakes, Sylvanite, and Burnside. His report has just been issued. This contains an account of the workings and plant of the Tough-Oakes and the Burnside and of the workings of the Sylvanite. The Tough-Oakes plant has a capacity of 120 tons per day and was operating until July, 1918, having produced gold worth £400,000 from 127,000 tons of ore, and paying small dividends for 1915 and 1916. At Burnside a 30 ton mill is nearly complete. As the Tough-Oakes veins dip into the Burnside, an amalgamation would be advantageous. Exploration at the Sylvanite was suspended on the outbreak of war, and consisted of trenches and several shallow shafts. The evidence obtained showed that the main line of lodes of the district traverses the property. The development could be done from the Tough-Oakes and the Burnside without further sinking.



Map of part of Kirkland Lake District.

United States.—The exploration by tunnel of the continuation of the Camp Bird lode in depth is being followed with unusual interest. The first reports of results tended to show that only straggling roots were to be found. The latest cable gives much more gratifying news. It is announced that, in the ventilating rise, which is now 290 ft. up, the ore is continuous, and that the width of the lode is increasing, the last 20 ft. averaging $50 per ton over 3 ft. In two other rises, similarly gratifying results have been obtained. At one place the ore averages more than 5 oz. gold per ton over a width of between 3 and 4 ft. We confess to having been rather doubtful as to the prospects of finding valuable ore below the old workings. Our congratulations to Mr. J. A. Agnew on the successful results now being obtained are, for this reason, all the more sincere.

Mexico.—Work at the Buena Tierra silver-lead mine, in Chihuahua, controlled by the Exploration Company, was re-commenced in May, 1918, and from then to the end of the year, 13,063 tons of ore averaging 10% lead and 10·9 oz. silver per ton was sold to smelters. The receipts were £29,379, and the profit was £7,373. Development is being vigorously conducted with gratifying results.

Colombia.—The Colombian Mining & Exploration Co. continues to provide mild sensations for the mining market. At a meeting of shareholders held in the middle of June, the chairman stated that the workings are continually filling with gold ore, or "anchadura," and that there is at present half a million tons of this material that can be extracted, some of it sampling 5 to 16 dwt. We presume that this is clayey gouge matter brought down by the heavy surface drainage characteristic of the district. Shareholders must not suppose that there is a perpetual spring of gold. They might ask the chairman whether the sampling he quoted truly covered the half-million tons. It is well to remember, also, that gold is difficult to extract from stiff clay.

The California properties of the Oroville Dredging Co. are now practically exhausted, and the American company is being wound up. Attention will in future be turned solely to the Pato and Nechi properties in Colombia. The Nechi property has been carefully nursed, until two months ago, in order to avoid so great a share of the profits going to Excess Profits Duty. Opportunity was taken to work some of the poorer ground and also part of the ground of the Pato company. The latter work was done in order that the tailing should form a barrier between the river and the men's quarters, which were often in danger from floods during the rainy season. The richer gravel is now being treated. The present returns show yields of 67 to 98 cents per cubic yard, with operating costs at 10 cents. The ground is easy to work, as may be judged by the fact that 62,000 yards was handled in a week by a dredge with 9 ft. buckets.

At the meeting of the Oroville company, the chairman gave some information about the Constancia lode-gold mine recently acquired by the Pato company. This mine is situated a mile north-east of Anori, on the Anori river, which is a tributary of the Nechi river, and is 44 miles south-west of the Pato property. The purchase price is $180,000 in cash. It is believed that the property has been worked for 140 years, mostly by open-cut. The lodes and country rock are similar to those characteristic of the Mother Lode in Amador County, California. The principal workings are on two parallel veins, which occasionally join. On the fourth level each is about 6 ft. wide. From 1914 to 1918, gold worth $311,000 was extracted from 46,000 tons of ore. It is estimated that the present workings contain reserves of 200,000 tons averaging 6 dwt. or more per ton. It will be possible to mine 100,000 tons averaging 8 dwt. per ton for each 100 ft. sunk, and the cost should not be more than $3·50 per ton. Of the total length of the veins, 16,000 ft., only 2,400 ft. has as yet been exploited. Mr. Prichard recommends the erection of a mill with a capacity of 100 tons per day, at an expenditure of £70,000, to be enlarged eventually to 300 tons at an additional expenditure of £80,000. In order to provide the capital required an issue of preference shares is proposed.

Brazil.—The persistence of ore in depth at the Morro Velho gold mine, belonging to the St. John del Rey Company, is remarkable. The lowest horizon, No. 21, is 6,126 ft. vertically below outcrop, and though development is not complete, the results are as satisfactory as on the levels immediately above. On the 20th horizon the ore-body measures 935 ft. long with an average width of 16 ft., and on the 19th it is 942 ft. long with an average width of 14·8 ft. The assay-value of the ore has been increasing, standing now at 55s. 10d., as compared with 53s. 9d. the year before. The reserve down to the 21st horizon is estimated at 1,209,000 tons, sufficient to keep the mill going at full capacity for over six years. Mr. George Chalmers, the superintendent, gives particulars of the development of manganese properties belonging to the company. Despatches at the rate of 3,000 tons per month were just begun when the Armistice was signed. Exploratory work has also been done on bauxite deposits, which promise to become of importance in the future.

The developments at the Passagem gold mine, operated by the Ouro Preto company, have been comparatively encouraging recently, and discoveries on the 920 and 1,040 metre levels tend to show that the deposits are not giving out at depth as was expected. The mine is in the same district as the Morro Velho mine of the St. John del Rey company, but has not been so successful as regards either the continuity or content of the ore. During 1918 the assay-value of the ore treated was 7¼ dwt., and the income about balanced the expenditure. The company has recently commenced the extraction of arsenic from the ore, and the necessary furnaces have been shipped to Brazil for the purpose. In order to pay for this plant, purchase a new air-compressor, and expand development, the issue of debentures to the extent of £10,000 bearing 10% interest has been authorized.

Spain.—At the meeting of Minerals Separation, Ltd., it was announced that Col. A. C. Howard had been appointed resident manager in Spain. He is engaged in designing a plant to treat the Penarroya company's lead slime. Of particular interest is the news that this company also owns extensive low-grade copper deposits, which it will be possible to treat by the flotation process.

Siberia.—The report that the Bolsheviks had taken possession of the Lena gold mines is now declared to be false. A message from the assistant general manager at Lenskoie has been published stating that tranquil conditions prevail at the mines.

THE WANLOCKHEAD LEAD MINES.

By JOHN MITCHELL.

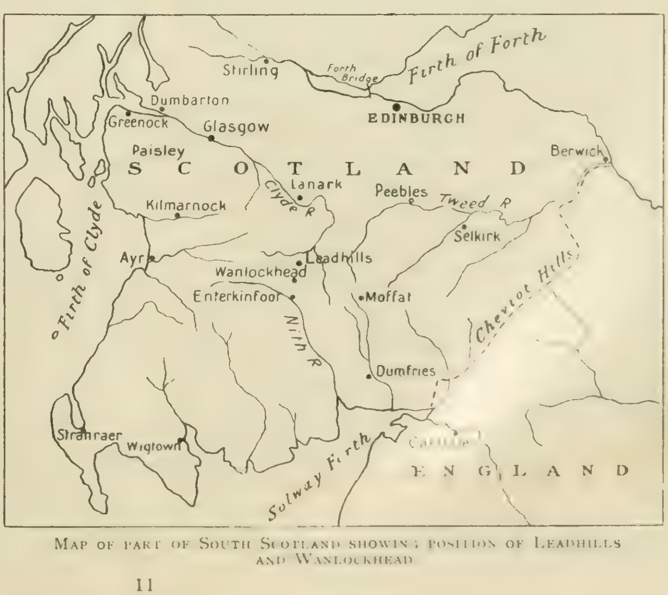
The Manager of the Wanlockhead lead mines gives particulars of a successful mining district in South Scotland.

THE Wanlockhead and Leadhills lead mines are situated in the uplands of the south of Scotland, and adjoin each other, Wanlockhead being in Dumfriesshire, Leadhills in Lanarkshire. All the streams from the Leadhills side flow into the River Clyde ; those in Wanlockhead reach the River Nith at Sanquhar, and so on to the Solway Firth. The two properties are owned by different landlords, Wanlockhead being the property of the Duke of Buccleuch and Queensberry, and Leadhills the property of the Marquis of Linlithgow. There are different companies working the mines. Wanlockhead has its head office in Glasgow, and Leadhills in London. Until a few years ago, the mines were much handicapped by being about seven miles distant from a railway station, and in former times, the lead had to be conveyed to Leith, the port of Edinburgh, in carts, a distance of 50 miles. There is now a branch of the Caledonian Railway into the two villages, and in Leadhills there are sidings that go right into the mines and dressing-floors. A very satisfactory service of passenger and goods trains is maintained. There is now direct communication with Glasgow, and other centres of industry. The villages are situated at an altitude of 1,200 to 1,400 feet, and are probably the highest in Scotland. They have a great attraction for visitors in summer, for the air is bracing and invigorating.

Although mining has been carried on for a long time, and very considerable returns made, the area so far worked, or proved, is small. Mining operations have practically been confined to the veins lying around the two villages. The veins have been proved for a length of about two miles from north to south, and about three miles from west to east. The geological formation is the Lower Silurian, the greywacke, or what is known locally as whinstone. This is a pretty hard stone, and does not vary much in the mining area. There are some beds of schist, and some slips, but none of these displace the veins to a great extent, although the schist until recently was supposed to have cut out certain of the veins that have now been found to be lead-bearing when driven through it. Though the geological formation does not show much variation, the filling matter of the veins varies widely. Some veins contain hard compact quartz, and others are filled with soft stone, which readily exfoliates when exposed to the weather. Some are filled with friable quartz, oxide of iron, and other vein matter. Most of them contain vughs or loch holes, from which some beautiful quartz and calcite crystals are obtained. Some of the veins contain a great variety of mineral specimens. The old heaps of the abandoned mines are a happy hunting ground for the mineralogist. There are collections of the minerals in most of the museums in Scotland, and some of the miners have very valuable collections.

There are records of the mines having been worked for lead in the thirteenth century. It is thought probable that the Romans may have done something in this field, as they had a camp not far distant and were not likely to overlook the lead mines.

In the sixteenth century there was a large amount of gold-washing done in the neighbourhood of the mines. There are records of gold



MAP OF PART OF SOUTH SCOTLAND SHOWING POSITION OF LEADHILLS AND WANLOCKHEAD to the value of £100,000 having been recovered in the course of a summer's working from the valleys of the Wanlock, Elvan, and Glengonnar. Anyone interested in the records of this working will find a detailed account in "God's Treasure House in Scotland," by the late Rev. J. Moir Porteous, D D. The gold was got from the gravel, and some very large nuggets have been found. Some of the miners still devote a little of their spare time to gold-washing. No doubt they find it an interesting pastime, and can sell the gold for more than its intrinsic value to people who have a fancy for a little native gold. Some people hold the opinion that there is still a gold reef to be discovered. Pieces of gold quartz have been picked up from time to time. Last summer Mr. Wilson, of the Geolcgical Survey, found a piece of quartz with gold through it, as large as a man's head.

There are records in Wanlockhead of continuous and sometimes very successful mining for 239 years without any suspension of operations. The first worker was Sir James Stampfield (1680—1691), then Matthew Wilson to 1710, then from 1710 to 1721 a company for smelting down lead with pit coal, probably that which came to be known as the London Lead Company. From 1721, there was more than one company operating in Wanlockhead at the same time. These were the Friendly or Quaker company, and the smelting company already referred to. These latterly joined together, and were succeeded in 1734 by Alexander & William Telfer. In 1755, the whole field of Wanlockhead was taken over by Ronald Crawford, Meason, & Company. This company, which in the end was owned by a late Marquis of Bute, worked the mines until 1842, when the then Duke of Buccleuch took the mines into his own hands, and worked them until November, 1906, when the present Wanlockhead Lead Mining Company took over the mines. All of the companies are not reported to have been very successful, but there were times when the mines were very rich, and no doubt large profits were made. The mines were successful until 1832, when the introduction of "Free Trade" brought the price of pig lead down to £11. 10s. per ton. Before that period, steam engines had been largely used, the company being about the first to avail themselves of these. Some of the earliest engines were erected at Wanlockhead. The low price of lead, and probably the poverty of the mines, led to the disuse of the steam engine, and water-pressure engines were substituted for pumping purposes. These were economical and good of their kind, but being dependent on water were not conducive to steady work.

Ronald Crawford & Company, who worked the mines for the longest period, had the assistance of some very able engineers, Smeaton of the Eddystone Lighthouse fame, Symington who built the first steamboat, also the Taylors who were connected with him in this, and other able engineers. The skill and courage they displayed in discovering and marking out the veins, and the way they laid out their works, reflects the greatest credit upon them. Many of the old works that are still extant give evidence of great skill and perseverance.

I may instance a tunnel that was driven from the Wanlock to the Mennock Valley, to bring in the water-supply which is still used for the working of the mine. This is 1,200 yards in length. It was commenced in July, 1763, and finished on November 4, 1774, having taken 11 years to carry through.

Much very interesting information regarding the early workings in Leadhills is contained in "God's Treasure House in Scotland." In this there is a record of the mines being let to the Monks of Newbattle in 1239. Even in these early times there was litigation, and it seems that it had stuck to the mines pretty much all through their history. It was through Mr. James Hope, an advocate, who successfully conducted a law case for an heiress to the mines, whom he afterwards married, that the mines came into the hands of the Hopetoun family, who still own them. The mines were held in high repute in those days, being called "God's Treasure House in Scotland," "and it is said that so great is the value of the lead that has been raised from beneath one of the mountains at Leadhills, that a competent authority has declared that it would suffice to pave its surface completely with gold guineas set on edge." The competent authority was probably what is now known as a mining expert, and perhaps it might be safe to take this with the proverbial grain of salt.

Coming to the year 1747, there were two mining companies working at Leadhills. One of these, the Scotch Mining Company, whose shareholders are said to have originated the Sun Fire Office, worked on until 1860 or 1861. Mr. Horner and others held leases on parts of the district at the same time. Mr. Horner's lease was purchased by the Leadhills Mining Company, but they were unable to work for want of water, and had a lawsuit with the Scotch Mining Company, which lasted upwards of twenty years, and cost £25,000. This led to no satisfactory result, and a compromise was entered into in 1861, by which the Scotch Mining Company relinquished their lease, and the Leadhills Mining Company obtained possession of the entire mining field. From that time the works have been carried on with considerable spirit and enterprise. Mr. Nevin, who was manager, laid out some very important works. He was very successful in discovering ore, and may be said to have laid the foundations of the prosperity that has since attended the mines and village. The present Leadhills Mining Company, Ltd., has been very successful; it has only a small capital to pay dividends on. The company from which it was reconstructed returned a large quantity of ore, but during most of its time the price of lead ruled low. For the last twelve or fifteen years, operations have been chiefly confined to the Brow Vein, which has been remarkably rich. The whole average of the ground cut has been high, probably richer than any other mine in the country, if we except the mines in the Limestone districts of England and Wales. The prospects in the bottom of the mine are still considered good. The veins in this grant are numerous, and are sometimes very rich. The last company obtained their ore chiefly from the Brown and Raike Veins. The Susanna Vein, which was worked in former times, is reported to have been very rich, and is yet considered to be far from being worked out. The trouble then was water. An attempt was made to restart this some fifty years ago, but the water again proved too much for the appliances then available. An engine of 300 h.p. was put in at Leadhills a year or two ago to generate electricity and drive air-compressors. There are also other engines, so that the mine is pretty well equipped with power. Modern rock-drills are used in the mines, also electrically-driven pumps and winding engines. The machinery throughout may be considered to be good, but a field of such promise as Leadhills is well worthy of being laid out on a more comprehensive scale, and of having a shaft, or shafts of decent size, these being vertical, or carried in a straight line. No extensive developments can be expected through the present shaft, which for half its distance is vertical, the other half following the dip of the vein at a flat angle.

For the last 52 years up to the end of 1917, Leadhills produced 88,796 tons of dressed lead ore. For the last ten years of that period the production was 18,162 tons of lead ore. Wanlockhead in the same period produced 91,509 tons of lead ore, and 8,654 tons of blende, and in the last ten years of that period 25,324 tons of lead ore, and 6,513 tons of blende. The returns before the period mentioned are rather difficult to get at. It is said that at the time of the law plea the books and plans were all destroyed, or removed from Leadhills, and there are no mining records in Wanlockhead office prior to the time that the Duke took over the mines. It is understood that there was an old journal of the workings, but that somehow disappeared a number of years ago. The Statistical Account of Scotland says that in the fifty years prior to 1835, Ronald Crawford & Co. expended at Wanlockhead the sum of £500,000, and during the same period raised 47,420 tons of lead. At the price then ruling the quantity of lead named would be worth about £1,000,000. From other records I have seen, the production about the year 1790 from Leadhills was 1,400 tons of lead, and from Wanlockhead 1,000 tons of lead, worth £20 per ton, or a total of £48,000, per annum. Taking it altogether there is little doubt that this has been a rich field, and that the works have been carried on fairly successfully over a long period.

When the War compelled the nation to look to its own resources, the lead mines were considered of national importance, and the Department for the Development of Mineral Resources was formed. Sir Lionel Phillips, the Controller, and several of the Department's engineers, visited the mines to see what could be done to increase production and help the country in its need. Among other things then suggested was the driving of an adit to serve both mines, and I was asked by the Controller to submit a scheme for a drainage adit. This was a matter that I had considered thirty years ago, when advising a company who were in terms for taking the mines from the Duke, and had almost completed negotiations for taking them over, when a difficulty arose owing to rich ore having been cut, and £2,000 per year, dead rent, being insisted on. At that time, I recommended the driving of an adit from Mennock, a distance of about two miles, to unwater the Wanlockhead mines down to the 80 fm. level. That same scheme at a later period was strongly recommended by a firm of engineers who inspected the mines for the Duke. It is a good scheme still, but when the Government were expected to take a hand in the matter, and the scheme was to serve both Leadhills and Wanlockhead, and it was thought the Government would bear a good share of the expense, and that the two landlords, as well as the companies working the mines, would all join in the expense, a bigger scheme was recommended, namely, to drive from Enterkinfoot, in Nithsdale, a distance of six miles to the Wanlockhead mines. This would intersect the veins in Wanlockhead at the 160 fm. level, where the present company has already driven over 300 fm. of a cross-cut, across the veins toward Leadhills, when the Leadhills company would have taken it up, and continued it across their area. This tunnel would have given backs of 80 fm. of fresh ground below the bottoms of most of the waterlogged mines in both grants. Most of these mines might be expected to prove well. All the evidence points in this direction. There is no change in the geological formation, and all the veins are known to be holding down strong. It is admitted and known that some courses of ore failed, or were lost through water difficulties and other troubles, but if fresh ground was opened out, there is little doubt that other courses of ore would be opened. In those veins that have been worked to a good depth, it is seen that a course of ore may fail in one place, and another be discovered in a different place.

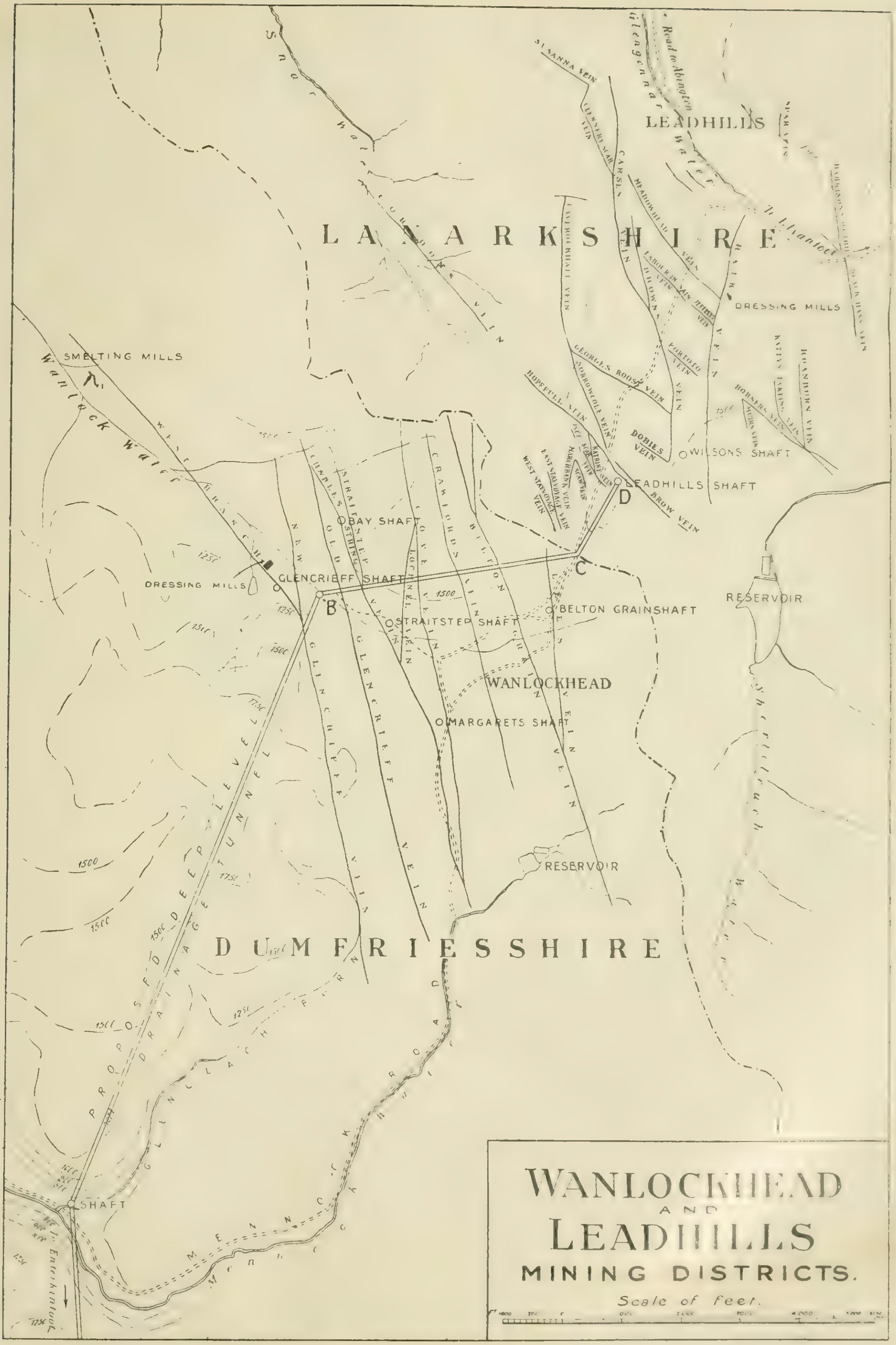
The New Glencrieff working in Wanlockhead, now at about 250 fm. from the surface, looks quite encouraging for holding down any depth. The Brow Vein at Leadhills, which is about the same depth, is also holding down good. These mines being a good distance apart, and there being a number of productive veins between, there is every indication that large quantities of ore may still be expected to be had from this district. That there is a large future for these mines I am firmly convinced, but the plan of operations to ensure success should be such as would enable work to be carried on at a greater depth, and on a larger scale than ever has been done in the past. If these come to be considered a national asset, probably the two properties would be worked as one. This would be an advantage and would effect a saving in several directions. The tunnel referred to, in addition to opening up the present mining area, would have come through fresh ground, where it might reasonably be expected productive veins would have been cut. It would also have given a chance to develop a large amount of power from water that could have been dropped to that level. The proprietors of the land would have been certain to reap large benefits from this scheme, and might have been expected to contribute to the cost, but as it turned out, they were strongly opposed to it, so nothing has been done.

Sir Lionel Phillips, in his report, refers to it as follows:

"The Wanlockhead & Leadhills Mines have produced, since the year 1856, 192,932 tons of dressed lead ore, and 6,982 tons of zinc concentrates, which represent in the first case about 95½%, and in the second 75% of the entire production of lead and zinc ores from Scotland, during the last sixty years.

"Constant expense and difficulties are being experienced in connection with the working of these mines, owing to the increasing cost of pumping, and a suggestion has been made for draining the whole district by means of a tunnel some 7 miles in length, which would tap the workings of these two properties at a low level, and at the same time would traverse a number of known lead veins, and possibly justify reopening some of the formerly productive mines. In addition to this, important discoveries might be made in ground hitherto unexplored. It is estimated that an expenditure of £150,000 would be involved in carrying out this work, but as it would take from five to six years to complete, it is clearly a matter for consideration after the war. It is one of those cases in which the State should certainly take a benevolent, and possibly a financial interest, if those directly concerned in the locality would incur the major risk."

THE WANLOCKHEAD MINES.—Having in the foregoing paragraphs described the mining district generally, I will now give details of the Wanlockhead mines, beginning with the time for which there are full records, that is, from the date that the Duke took over the mines. Mr. James Stewart—who had been connected with the management for some ten years prior to 1842—managed the mines for the Duke for thirty years, and I think with a very fair measure of success. The chief workings when he took hold of them for the Duke were the Lochnell and the Belton Grain. These became unprofitable, largely through inadequate means of dealing with the water. He then turned his attention to the New Glencrieff Vein, which had been abandoned as unprofitable, and stood idle for over seventy years. He also reopened both Bay and Straitsteps, from which considerable quantities of ore were returned. The New Glencrieff proved very successful, and is the lode from which the returns are still being made. He began with the mines comparatively poor, and left them rich. He had the satisfaction before he died of cutting a new course of ore, which has probably yielded as much as any shoot of ore ever discovered in Scotland. He also put up a new dressing mill, and laid out new smelting and desilverizing works on a good scale. This gentleman was succeeded by his son, Mr. T. B. Stewart, who also managed the mines for a period of about thirty years,


LANARKSHIRE
DUMFRIESSHIRE
LEADHILLS
WANLOCKHEAD
SMELTING MILLS
DRESSING MILLS
DRESSING MILLS
GLENCRIEFF SHAFT
BAY SHAFT
STRAITSTEP SHAFT
BELTON GRAINSHAFT
MARGARETS SHAFT
LEADHILLS SHAFT
WILSONS SHAFT
RESERVOIR
RESERVOIR
SHAFT
PROPOSED DEEP LEVEL
DRAINAGE TUNNEL
GLENCRIEFF VEIN
GLENGONNAR WATER
WANLOCK WATER
BROW VEIN
DOBIES VEIN
GEORGES ROOST VEIN
WANLOCKHEAD
AND
LEADHILLS
MINING DISTRICTS.
Scale of feet.

and raised a large quantity of ore from the New Glencrieff and Straitsteps Veins. In his time, he replaced the dressing mill with new crushing machinery, and self-acting jigs, a pretty little plant, but too small for the requirements of the mine. He also introduced a new water-condensing plant with an elaborate system of flues for catching the fumes at the smelting mill, which resulted in a great saving of lead. He had unfortunately to contend with low prices. In the latter part of the Duke's time, things were allowed to drift. The appliances for many purposes were inadequate, and nothing was done to provide necessary machinery for draining the mines or to depart from old ways and customs that had become obsolete, and it is said the works were carried on at a loss.

Arrangements were made with the present company for taking over the mines in November, 1906. The company started with high hopes, some of the principals believing that the mine was very rich, and only required a little capital to make it—as one of the directors put it—a gold mine. As the difficulties encountered were greater than expected, no doubt some disappointment was experienced. After a period of some hesitation, the necessary matters were tackled with skill and determination, and taking the results as a whole, from the start to the present time, the mine has done very well. In the last eighteen months, this mine, with other lead mines, has received some help from the Government, but not sufficient to compensate for the increased price of labour and materials, considering that the price of lead was controlled at a low figure during the war, and de-controlled as soon as it was over, when the Government had heavy stocks to put on the market.

Since the present company took over the mines, they have deepened it to the extent of 100 fm., over a length of nearly a mile. In that time they have cut 195 fm. in shafts, 1,052 fm. in rises and winzes, 6,075 fm. in driving, 28,896 fm. in stopes and other excavations, altogether a length of 41 miles. In addition to the regular developments of the mine, they put out a trial level to the south at the 120 fm. level, a distance of half a mile. This was only successful at the start, where very good ore was cut, much more than sufficient to pay for the driving, but the remainder of the drivage was disappointing, although at times it looked promising. They also extended the two branches of the vein north, a very considerable distance beyond the former workings. On the west branch, they did not meet with the success that might have been expected considering the size and strength of the vein; still, sufficient ore has been had from there to pay for all the driving, and good ore is still being raised. A strong opinion is held that further extensions in this direction will open good ore. On the eastern or main branch of the vein going north, the management formed the opinion, from certain evidences that they discovered, that lead might be had there by driving through the barren part, at which the drivages had formerly been suspended. The drivage here did not prove as encouraging as might have been expected, and to make matters worse, some joints led the drivage a considerable way off the proper track ; the survey showed it to be 20 fm. off the usual track. It was decided to cross-cut this 20 fm., and say as little about it as possible. The 20 fm. was driven and nothing was discovered. Some engineers who visited the mines said, " What are you driving there for ? " Others said we would not get anything there. Although disappointed at not cutting the vein at 20 fm., it was resolved to go on, and at 21 fm. the vein with lead in it was cut. Some 11 fm. was opened at that place, worth 15 cwt. per fm. A considerable distance was driven on a nice vein, but with nothing to value, when a shoot of ore 50 fm. in length was cut, which is valued at 1½ tons of lead ore per fm. The drivage has been extended through that, and other small spots of lead have been cut. This is at the 160 fm. level, and is in whole ground to surface. Two deeper levels are being driven up to this point, the 200 fm. and the 240 fm. There are several veins in this hill both to the right and to the left, which may also be found to continue productive when driven through the schist. Great things are expected from this part, which is practically a new mine.

Another trial of considerable importance that is now being carried out is a cross-cut at the 160 fm. level to the east, under some of the waterlogged mines, 80 fm. below any of the former workings. This has already intersected some promising veins, and is expected to cut others shortly. It is now in about 320 fm. It has been carried a fair size, being 7 ft. by 7 ft. and perfectly straight.

When the present company took over the mines, all the drilling was being done by hand. The men were generally good single-hand borers, some of them being experts at this work. The practice was to drill holes of a small diameter, using the highest class of explosives. The holes being placed to the best advantage, this class of work was hard to beat as to expense; but it was not possible to get sufficient men to work on the scale that the company desired, so rock-drills were immediately introduced for driving the levels. These were of the heavy reciprocating type, and did good work, but were heavy to handle, and not at all suitable for the stopes. A lighter type of the same class of drills was tried in the stopes, but with only a moderate amount of success. Early in 1909, hammer-drills were introduced, and of these a number of different types have been tried. Two of the first types that were tried were water-flushed, and did very satisfactory work, but the renewals of working parts were expensive. The dry boring type were effective and fast borers, but it was seen that these would injure the health of the men. When water-flush devices of different sorts were applied to these, good work was done with them. Some of these were self-rotating and self-feeding, and when all was going well, the man could stand and look at the drill boring, but the spare parts were still a serious item of expense. All the drills that were tried in the stopes were fixed on a column and radial arm. The same method of fixing is still employed, but all the drills mentioned have been discarded in favour of air-feed telescope drills, which are hand-rotated and water-flushed. These are much simpler in every way. There is no rotation gear, and little mechanism to get out of order, and the expense of running is very small. A heavier type is used in the drivages than in the stopes, the former being 100 lb. weight, the latter 56 lb. weight. These are one-man drills, but there are generally two men with them in the stopes. One man works the drill, the other being engaged sorting the stuff, and so on, there being quite as much work sorting and picking the stuff as there is breaking it down. In the drivages there are two men and two drills. A round of 18 holes, about $3\frac{1}{2}$ ft. to 4 ft. deep, is generally put in each shift.

The method of working for some time back has been to sink 40 fm. before putting out the drivages. When the drivage cuts ore, a rise or winze is generally put through, effecting communication with the next level. Then the ore ground is worked away by overhand stoping, the method being to lay a floor with 3 in. planks, keeping the same at least 4 ft. in advance of the heading; then the round is blasted down on the planks, the stones being picked out and thrown forward to fill up, and so allow the floor to be extended for the next blast, and the lead wheeled or shovelled to a pass behind. These passes, being closed at the bottom, form a hopper from which the stuff is run into the tram wagons, and drawn to the foot of the shaft by ponies, which draw four wagons each journey. At the bottom of the shaft, the stuff is tipped into a skip, which is self-dumping, and empties into another wagon at the top of the shaft. From there it is taken to the screens or grizzlies, which are only a short distance from the shaft.

There is no trouble experienced either in putting the rises or the winzes through the 40 fm. Some of the drivages have been put out half a mile without experiencing any inconvenience as to ventilation, a 9 in. pipe being carried for the purpose of ventilation, with a water jet fixed every 50 fm. These jets have a head of anything from 20 to 80 fm., as circumstances may permit. Formerly the stuff was all trammed by manual labour. The introduction of the ponies into the mine saved much hard work, and was a great saving to the company. Before the ponies could be introduced, the whole of the tram roads had to be re-laid in a substantial manner, and some of the old levels had to be made larger. The new levels are always driven ample size, these being generally about 6 ft. wide by 7 ft. high. In the cross-cut we are now driving, very good work is being done. Two men blast a round of fully 3 ft. deep, two men in the next shift lifting the stuff, so that eight shifts generally cut a fathom of ground and fill the stuff into wagons for the pony.

The efficiency of the underground men is now about three times greater than when the company took over the mines. Of course the expense is not reduced in the same ratio, but the rock-drills and air-winches are a great saving of labour, also the haulage by the ponies, and things are so arranged that there is much less handling of stuff in the mines. There are still a great many things that could be improved. The small shaft is a serious drawback. It has one good feature, it is perfectly straight, but the two compartments for winding only take a cage 2 ft. 9 in. by 2 ft. 6 in. It was thought at first that a pony could not be got down, but when they have their legs tied up to their body, it is wonderful how small a box they go into, and they go down quite comfortably by that method. A good size horse could go down quite well if required.

The whole of the old plant at the mines and dressing mill was scrapped, and new plant put in by the present company. They also put in a temporary pumping plant when they took over the mines, which was discarded as soon as more permanent arrangements could be made.

There are three Babcock & Wilcox steam boilers, having a combined heating surface of between 6,000 and 7,000 superficial feet. These provide steam for the pumps in the mine, the largest of these being a Riedler pump, at the 160 fm. level, which throws 400 gallons of water per minute to the adit level. There is another of the same class of pump at the 80 fm. level, with a capacity of 300 gallons, which it also delivers at the adit level. This last is only worked at times when the water is heavy. There are other pumps in the deeper levels, as well as auxiliary pumps in several parts of the mine, which are all driven either by steam or air. The steam pipes are well covered with non-conducting material. The pumps are considered to be fairly efficient, but the mine is getting deep, and there is a limit to where steam can be efficiently used.

There are two air-compressors, one 750 cubic feet of free air per minute, which is now kept as a standby, another of 1,000 cubic feet, which is a very efficient machine and supplies air at 80 lb. pressure for all present requirements. The boiler plant also supplies steam for the winding engine and the two engines that drive the dressing plant, also two small engines for hoisting waste.

At the dressing plant the stuff is tipped over grizzlies, the oversize being shovelled on to a pan conveyor, where the stones are picked out. This conveyor delivers into the stone-breaker, from which it drops on to another conveyor, which deposits it in the hoppers behind the crusher. The smalls from the grizzlies are run into these hoppers by small tram wagons. The stuff then falls on to a shaking screen, which takes out the small, and gives a regular and steady feed to the roller crushers. These are 30 in. by 16 in., the one being a duplicate of the other. The ore is elevated from the crushers to the trommels. There are two series of seven trommels, the first being 10 m.m., which returns the oversize to the crusher, and the last 2¼ m.m. These serve fourteen four-compartment jigs. The slime plant consists of six Buss tables, 3 James sand tables, and 3 James slime tables ; a double dipper wheel raises the middlings for re-treatment ; there are also a double system of water classifiers for sand tables, saddle-back classifiers for the finer tables and slimers, and two mechanically worked dolly tubs. The chat plant consists of a small roller crusher with six jigs, four of these being four-compartment. In commencing to jig through a 10 m.m. hole, there is not a great deal of clean ore recovered at that size from the first jig, but a good deal of clean waste is thrown off, and the chats are taken to the chat mill to be re-crushed. The waste from the jigs is clean and free from ore. The slime plant is effective, but it might be further extended with advantage, as it is difficult to get the very last of the ore out of the slime. The lead ore is trammed to the smelting mills. The blende, which is dressed up to 50 or 52% zinc, is sold to the zinc smelters.

As the mines are in a high place, and get more than the usual quantity of frost and snow, the machinery is all housed in a steel-framed corrugated-iron shed, which is heated with steam, the water being brought from the reservoir in earthenware pipes, which are deeply covered in the ground. The severity of the weather does not prevent dressing being carried on regularly.

The lead-smelting plant is situated about one mile from the dressing floors, and consists of two roasting furnaces, five Scotch hearths, and one slag hearth. There is a water-wheel, which drives the blower for the Scotch hearths. It also drives an exhaust fan to take away any smoke that may be blown out to the injury of the men working. Only the slime ore is roasted, the rest being fed direct to the Scotch hearths. These are simple to run, are economical for fuel, and, as the ore is clean and of uniform quality, they are considered to be the most suitable for the requirements here. This system of smelting has one disadvantage, namely, a large percentage of the ore is carried away in fume. But there is a very good system of condensing here, and a large proportion is recovered. The condensing plant consists of a brick condenser, in which the smoke travels through a number of chambers, where a fine spray of water is brought to play on it, and washes the bulk of the fume into settling ponds, the remainder being caught in long flues that wind round the hill, very little escaping through the stack at the top. Up to 1910, the lead was desilverized on the mine, but owing to the then low price of silver and the scarcity of labour, it was found more advantageous to sell the silver-lead to silver refiners, who had more up-to-date plants. The process practiced here was the Pattison, which made a high class of refined lead, the Queensberry brand having a good name in the market. The silver was made quite pure, and sold to the silversmiths.

The company put in a private siding at the railway station, and made a tram road to the smelt mills, a distance of two miles. The coal, ore, and other materials, are drawn over this by horses to the bottom of a steep incline by

GLENCRIEFF SHAFT AND DRESSING PLANT OF THE WANLOCKHEAD COMPANY.

the station, where the tram wagons are hauled up to the railway station by an air-winch.

The following table may be interest as showing the cost of mining and dressing for the twelve months ended December, 1914, as compared with twelve months ending December 31, 1918:

	1914 £ s. d.	1918 £ s. d.
Total Cost per fm.	7 17 5	18 16 3
Cost of Wages per fm.	3 11 11	8 6 10
Cost of Fuel per fm.	1 2 3	3 6 7
Cost of Explosives per fm.	0 11 3	1 4 5
Cost of Stores per fm.	0 18 4	1 18 1
Cost of Timber per fm. (Mining).	0 4 8	0 16 2
Total Cost per ton of Lead Ore and Blende	7 9 8	22 11 1
Cost of Wages per ton of Lead Ore and Blende	3 8 5	10 0 1
Cost of Fuel per ton of Lead Ore and Blende	1 1 3	3 19 11

The produce of the mines has not increased in the same proportion as the cost, and the Wanlockhead mines, although not at present in any financial straits, are looking to the future with considerable anxiety. In the report of the last general meeting of the Leadhills Mining Company, the chairman stated that they could not go on without drawing on their capital if the War Bonus was not refunded by the Government. The managing director intimated that they would not carry on at a loss. The Wanlockhead Mining Company have intimated to their workmen that they are seriously considering the position as to whether they will go on working at a loss, now that the Government are not refunding the War Bonus. The position is certainly difficult, but I think that mines that are in a position to do so might take some risk, as one might hope that the present times are abnormal, and that the price of lead at least will in time adjust itself to the prices ruling for labour and materials; but no doubt the position is full of uncertainty, and there may be a stoppage in both the mines. If there was mutual goodwill between the companies and the workmen, and no further increase of costs, I would recommend any that I had to do with to go on. If costs are to continue to increase without a corresponding increase in the produce, I would hesitate to make this recommendation. The efficiency in Wanlockhead has been considerably increased, and could be still further increased. The company can do something in this direction, and the men can do a great deal by duly recognizing the value of their own time when at work, keeping the machines and machinery steadily at work, and by the careful use of the machines and materials supplied to them.

The following comparative figures of lead, zinc, etc., produced show that, as to production, Wanlockhead and Leadhills are above the average per person employed, as compared with the lead and zinc mines of the United Kingdom.

	1914			1917		
	£	s	d	£	s	d
United Kingdom... Approximately	109	2	4	136	0	0
Wanlockhead	188	[illegible]	4	225	12	4
Leadhills.....Approximately	153	8	0	221	0	0

It would be useful information if every-one had to give the amount of the ground cut, and its value, as well as the amount recovered. Taking 16 tons to the fathom, the value of the stuff broken in Wanlockhead in 1914 gave 4·95% of dressed lead ore, and 1·62% of blende, having a total value per fm. of £10. 9s. 6d. In 1917, the figures were 3·59% lead ore, 1·34% blende, value £13. 13s. 8d. Leadhills for the same period would give for 1914, say, 10% of lead ore, and total valve per fm., £19. 7s. 0d.; for 1917, 7·52% of lead ore, and total value per fm. for lead ore and value, say, £25. 9s. 9d.

Leadhills has been much the richest of the two mines for a number of years back, and has probably larger reserves of rich ore ground laid open for stoping, but looking a few years forward, it would be very difficult to say which would be the most productive. It is greatly to be hoped that both mines will continue to go on, and be successful, as it is no light matter for 2,000 people to be thrown out of employment, especially in a district like this, where the people have much to attach them to their mountain homes, but it would be particularly sad after so many had gone out to fight for the country, numbers of whom will not return. It is to be hoped that those who have fought for their homes will not find that they have to look for new ones now that they are home. Those who remained at home did so because the Government wanted their work here. The women also in Wanlockhead came forward, when asked, to help to carry on. Some thirty women gave their services to the mine in Wanlockhead in the time of need, no women having ever been employed in the mines before. They deserve credit for the good work they did. I think that if the mines had a price for their products commensurate with the increased rates of labour and materials, they could still go on and prosper.

For many years the mines have provided a living for a most respectable and industrious class of people.

One of their own poets says of the men:

> For the chiels are as likely a set as ye'd meet,
> Frae the muir and the glen tae the square and the street,
> Big, buirdly, and bauld, like the hills o' their hame,
> And no cruppen doon wi' inherited shame;
> But gaun frae the knee tae their grave in the glen,
> Like their faithers afore then, the walins o' men.

I am indebted to the Wanlockhead Company for the use of their plans, and to Mr. William Mitchell for preparing plans and sketches.

Magnetic Surveys as an aid in Geological Examination.

The report for 1918 of the Conjoint Board of Scientfic Societies contains some information relating to magnetic surveys at Melton Mowbray and Irthlingborough, in Leicestershire, undertaken by Messrs. G. W. Walker, A. H. Cox, and Ernest Wilson. The last-named devised an instrument for determining magnetic susceptibilities. The chief results of the investigation may be summarized as follows: It has been proved that the relatively small magnetic disturbances at Irthlingborough may be correlated with the presence there of the bed of Northampton iron ore. The Melton Mowbray disturbances, however, cannot be attributed either to Jurassic ironstone, or to any sedimentary deposits which may underlie the area. Any deposits of the ordinary iron-ores (ferrous carbonate or red or brown hematite), had they existed, must have lain so near the surface in order to produce the observed effects, that they could scarcely have escaped detection by ordinary geological examination. These disturbances, on the other hand, appear to be connected with the tectonics of the deep-seated formations. The investigation has led to two important conclusions: 1. With a suitable modification of the instruments the small magnetic disturbances caused by the Jurassic iron-stones are capable of detection, and may be of use in determining the boundaries of concealed fields of these ores in areas not affected by larger disturbances due to other causes. 2. It promises to throw light upon the tectonics of the older rocks where overlain by more recent formations, and thus to afford assistance in solving problems of great practical importance, such as the determination of the limits of concealed coalfields.

MODERN ROCK-DRILL PRACTICE.

By DAVID PENMAN, B.Sc., M.Inst.M.E.

INTRODUCTORY.—Next to the invention of gunpowder and dynamite nothing has contributed so largely to progress in tunnelling, shaft-sinking, prospecting, and development work generally as the introduction and improvement of the mechanically-operated rock-drill. The process of drilling shot-holes in hard stone was slow and laborious in the extreme when the only available means of doing so consisted in utilizing the force of gravity and the power of a man's arms. But with the advent of the successful machine drill a new era was initiated in which rapid progress even in the hardest ground was possible and man-power could be utilized to an extent and with an effectiveness never dreamed of under the old conditions. The credit of inventing the first self-operated rock-drill belongs to the United States of America, where Couch of Philadelphia in 1849 patented his machine. Previous to that, Trevithick, in Cornwall, applied a rotary steam-driven boring machine to drilling shot-holes in limestone near Plymouth, and Brunton, of the same county, invented a machine called a wind-hammer which was driven by compressed air. Also in America two brothers, J. M. and J. N. Singer, used a large drop drill, of which twelve were put in use, in the blasting required in the construction of a canal in Illinois. None of these appliances, however, can be strictly termed the forerunner of the modern power drill, and probably the first invention embodying the principle underlying the action of the present-day machine was that patented by J. M. Fowle, of Boston, U.S.A., in 1850. This drill was operated by steam; the possibilities of compressed air had not then been fully realized. The drill bit was made to form an extension of the piston rod and the whole machine was fed towards the rock as the drill tool advanced in the hole. The piston was given a slow rotary motion. In Germany in 1853, Schumann used a drill in the mines near Freiberg which exhibited, though in an imperfect form, many of the features of the modern power-drill. In France, too, in 1855, M. Fontainmoreau invented a drill operated by compressed air which had both a rotary and a forward movement, while M. Sommeiller in 1861 to 1863, using an improved form of Mr. Bartlett's drill (patented in 1855), did very good work in the Mt. Cenis tunnel and in the mines at Moresnet, Belgium. This latter drill was also actuated by compressed air. These drills were the precursors of the modern hammer-drill. The air was caused to produce a rapid succession of blows on the end of the boring tool. About the same time a drill invented by Gen. Haupt, and subsequently improved by Taylor, was employed with good results in the St. Gothard tunnel. This machine was further improved by Burleigh, who used it in the Hoosac tunnel in Massachusetts.

Mention should also be made of Pidding, who used a reciprocating hammer-drill, operated by steam, as early as 1853, of Schwarzkopf, Sach, Lisbet, and Bornhardt on the Continent, and Crease in England, all of whom did something to advance the development of rock-boring appliances during the early sixties of last century. The proper automatic rotation of the drill steel was a difficulty with the early inventors, and it was not till 1866 when Jordan and Darlington invented the rifle bar and ratchet method that the problem was adequately solved. In 1870 Osterkamp attempted to anticipate the now well-known hand hammer-drill in so far as the holding-up of the drill is concerned, but the recoil of the machine was too great and the drill had to be mounted on a carriage or frame. Thereafter followed drills by Beaumont and Appleby (though this was a rotary drill), Ferroux, Darlington, Burleigh, McKean, Franke, Schram, Ingersoll, and many others. The valve motion of the earlier drills was either of the tappet type or of the piston variety. For example, the first Climax, and the Rio Tinto drills used the tappet valve, while the Darlington and the Adelaide had no proper valves, the piston itself acting as the valve. The tappet valve proved a success and is still used in modern drills, but the valveless drill, though simple and having few moving parts, was a poor hitter, and the principle was abandoned, to be revived, however, in the modern valveless stoping drill. In the subsequent developments many makers have vied with each other to produce a powerful and reliable drill. First place must be given to our American cousins for the great work they have done in bringing the rock-drill to its present stage of perfection. Chief among American makers who have a well-earned reputation in the history of rock-drills are the Ingersoll-Rand, the Sullivan, the Chicago Automatic Tool, and the Denver Rock-Drill companies. In England, Holman Brothers and Mr. W. C. Stephens, of the Climax company, have done a vast amount of work in the development of both the piston and the hammer-drills. Various manufacturers in Sweden, Germany, France, South Africa, and Australia have likewise contributed to the general progress.

In the present article attention is given to those drills which have proved of outstanding worth as well as to some of the more recent improvements. It must be borne in mind, however, that the number of drills on the market to-day is very great and that in a comparatively short article it would be impossible to give anything like a full description of all the successful machines.

THE PISTON DRILL.—In this form of rock-drill the drilling steel is fixed in a chuck attached to an extension of a reciprocating piston. The piston and the bit therefore move together. With such an arrangement the machine itself must necessarily be of considerable weight, making it imperative to fix the drill to some form of support. This renders it unsuitable for some purposes. Nevertheless, partly by reason of its size, which enables a powerful blow to be struck, and partly from the efficient sludging or mudding produced by the to-and-fro motion of the steel in the drill-hole, it is admirably adapted for most kinds of development work, such as the sinking of shafts and winzes, the driving of levels and cross-cuts, and wherever deep shot-holes are required. There are many drills of the reciprocating type in use at the present day and the principle of action of all of them is the same, though each possesses its own little differences in detail.

For the purpose of explaining in general terms the operation of a reciprocating rock-drill, the Holman drill, which has been in use for many years and which has done very good work, may be selected. Referring to Fig. 1, P is the piston, which is provided at its larger diameter with leather piston rings so as to render it air-tight in its cylinder. The piston-rod R, which is an integral part of the piston, extends through the cylinder head, which is bushed so as to reduce friction and secure air-tightness. The piston-rod terminates outside the cylinder in the U-bolt chuck U which is designed to grip the drill steel by means of bushing, gripping pad, and wedge. The bit is placed in position and the wedge pressed forward by hand. The grip of the chuck on the steel is tightened by the first few blows of the piston against the rock. A blow with a hammer or jumper promptly loosens the wedge and releases the drill steel. The nuts on the U-bolt are chiefly for adjustment, and to compensate for stretch and wear. In the position shown in the figure live pressure air is entering the cylinder behind the piston which is on its forward or hitting stroke, while the air in front of the piston is escaping to the atmosphere through the exhaust port. The valve V controls the admission and exhaustion of the air. This action is described in detail later. On the hitting stroke the piston shoots straight, and the drill-bit strikes a clean and powerful blow on the rock at the bottom of the drill-hole. On this stroke the rifled bar B is rotated slightly. Just before the end of the stroke the valve is thrown over so as to admit live air in front of the piston and connect the rear with the exhaust. The piston now makes the backward stroke, pulling the drill-bit outwards in the hole. During this stroke the piston, which carries a twist nut, is given a slight rotation by the rifled bar, the latter being prevented from rotating by a ratchet and pawl arrangement at its rear. Thus on the next forward stroke the drill-bit strikes at a different part of the bottom of the drill hole. As the hole deepens, the cylinder, which slides in two V-shaped guides, forming the cradle, is fed forward by rotating the handle H of the feed-screw F, which works through a nut in the drill casing under the cylinder. In addition to providing a means of keeping the drill up to its work, the feed allows of a variation

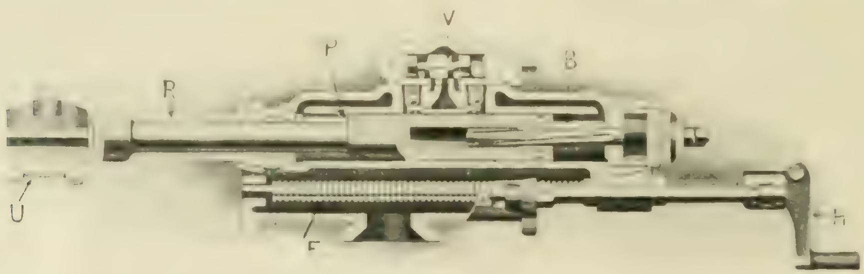


FIG. 1. THE HOLMAN PISTON DRILL.

in the length of stroke of the piston. When it is required to withdraw the drill-bit from the hole, the drill cylinder is run back on the screw, the air pressure having been previously cut off. The drill is built in sizes ranging from $2\frac{1}{8}$ in. diameter and 5 in. stroke, to $3\frac{5}{8}$ in. diameter and 7 in. stroke. The heavier drills are chiefly used in development work and in tunnelling and quarrying, while the $2\frac{1}{4}$ in. and the $2\frac{1}{2}$ in. drills are intended for use in the stopes. The weights of the last-mentioned drills are 100 lb. and 140 lb. respectively. The heaviest size weighs 380 lb. The length of feed varies from 18 in. in the $2\frac{1}{4}$ in. drill to 30 in. in the $3\frac{5}{8}$ in. drill. The larger the drill of course the larger the diameter and depth of hole which can be drilled easily. Thus, where particularly heavy charges of explosive are desirable, the heavier the drill the better within limits and consistent with other desiderata. For stope work a light drill is essential. Other well-known piston drills are the Ingersoll-Sergeant, Chicago Giant, and Slogger, Stephen's Imperial, Climax, Siskol, Denver Waugh or Dreadnaught, Sullivan Liteweight and Hyspeed drills. The valve-action of several of those drills will be described.

THE HAMMER-DRILL. — The hammer-drill differs in principle from the piston drill in respect that the drill steel is not attached to the piston rod but is held at rest in the chuck, and instead of being reciprocated is simply struck a series of blows from the rapidly moving piston or hammer in the cylinder of the drill. The idea of the hammer-drill is an old one, but it was not until comparatively recent years that it attained the high degree of perfection which has enabled it to be utilized to such an extent as is seen to-day. Probably no single individual has done more to develop the hammer-drill than Mr. George Leyner, of Philadelphia, whose name will be always associated with the history of rock-drilling. Leyner was one of the first to foresee the great possibilities of the hammer type of drill. The drill was primarily designed for light work and comparatively shallow bore-holes, but it proved so successful for this purpose and it possessed so many advantages over the large and heavy reciprocating drill in regard to portability, ease of handling, and suitability for cramped and awkward situations that manufacturers soon began to produce models suitable for a much wider range of work than was at first thought practicable. Now they are being used to an enormous extent for almost all conditions of rock-drilling, both in coal and metalliferous mining.

The chief requisites of a good hammer-drill are: (1) strong and compact in construction, (2) light in weight, (3) effective in drilling, and (4) simple in construction and operation. Every manufacturer of rock-drills now includes one or more forms of hammer-drills among his products. All of them endeavour to produce a drill to conform to those requirements, and where all are so good it is a difficult matter to discriminate. Some of the best-known makes are the drills of the Holman and Climax companies, the Flottmann, Jackhamer, Hardy-Simplex, Sullivan Rotator, and Leyner-Ingersoll drills.

FIG. 2. THE HOLMAN HAMMER-DRILL.

The parts of a hammer-drill are clearly shown in Figs. 2 & 3, showing a Holman and a Climax Britannia respectively. In Fig. 2, H is a freely moving hammer which strikes a rapid succession of blows—2,000 to 3,000 per minute—on the anvil A, which transmits the force of the blow to the drill steel D, which in turn transfers the impact to the rock. In the Jackhamer and similar hammer-drills the anvil is omitted and the hammer hits the steel direct.

The hammer-drill may be subdivided into three classes, namely (*a*) those which are simply held in the hand, that is, hand hammer-drills, (*b*) those which are designed to be mounted on supports and have a screw-feed similar to the reciprocating drill, that is, cradle hammer-drills, and (*c*) those with automatic telescopic air-feed. The last is illustrated by Fig. 2 and the first by Fig. 3.

THE VALVES.—There is no more important part of a successful rock-drill than the valve motion. The types of valves in use may be

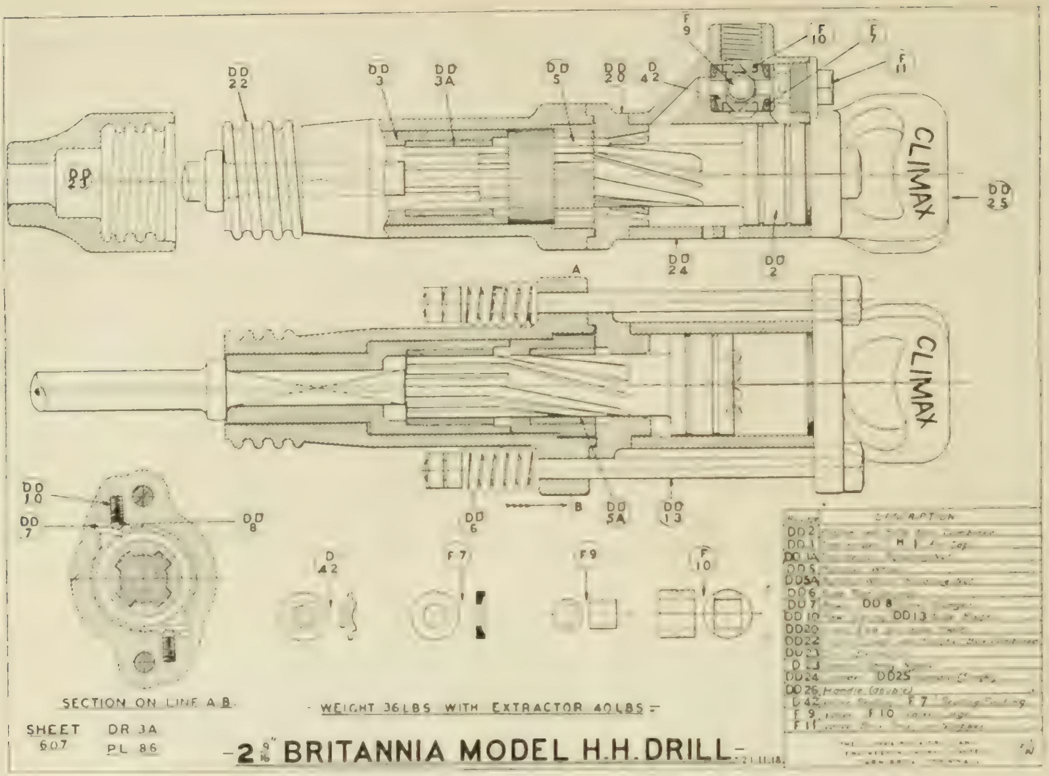


FIG. 3. THE CLIMAX-BRITANNIA HAMMER-DRILL

divided into the following classes:

(1) The tappet valve;
(2) The spool or air-piston valve;
(3) Auxiliary-operated valves;
(4) Piston valves;
(5) The flap valve;
(6) The ball valve.

THE TAPPET VALVE.—This valve was the earliest successful form for regular work. Examples of drills in use which employ the tappet valve are the Chicago Giant and the Climax drills. Referring to Fig. 4, the piston will be seen to have two enlarged portions. As shown in the illustration, the piston is just on the point of making the forward stroke, the valve V being in the position which allows live air to pass into the cylinder port P_2 and thence into a space behind the piston; the front of the cylinder is in communication with the exhaust E through the port P_1. When the piston has nearly reached the end of its stroke the raised portion lifts the rocker, which shunts the valve into the position for reversing the stroke of the piston. In the Giant drill illustrated the rocker and valve is actuated chiefly by the rear end of the piston; while in the Climax either end operates the valve alternately. The tappet valve is positive in action and it cannot readily stick. It is the only form which is equally suitable for air or steam, as in the spool valve the condensation of the steam interferes with the action of the valve. Makers who use the spool valve in their air drills have for this reason to employ the tappet valve where steam is to be the motive power. On the other hand the tappet valve is more subject to breakages than the spool valve.

The Corliss valve used in one form of the Wizard drill differs somewhat from the ordinary tappet valve. Two tappets are used and these, operated by inclined surfaces on the piston, impart a rotary or turning motion to the valve. It is claimed that the quick and easy valve action obtained, combined with liberal port area, provides a means of changing rapidly from pressure to exhaust and so ensures rapid reversal of the piston. By this means a high velocity of operation is attained.

THE SPOOL VALVE.—An example of this form of valve is that used in the Siskol drill. In Fig. 5 the piston is making its forward stroke. The valve is in the position which allows live air to pass down the port C into the cylinder D. At

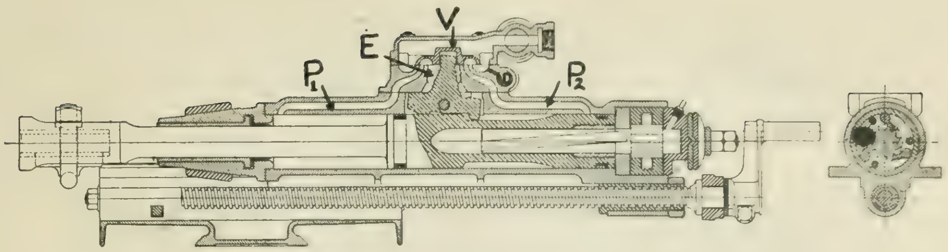


FIG. 4. THE CHICAGO GIANT DRILL, SHOWING TAPPET VALVE.

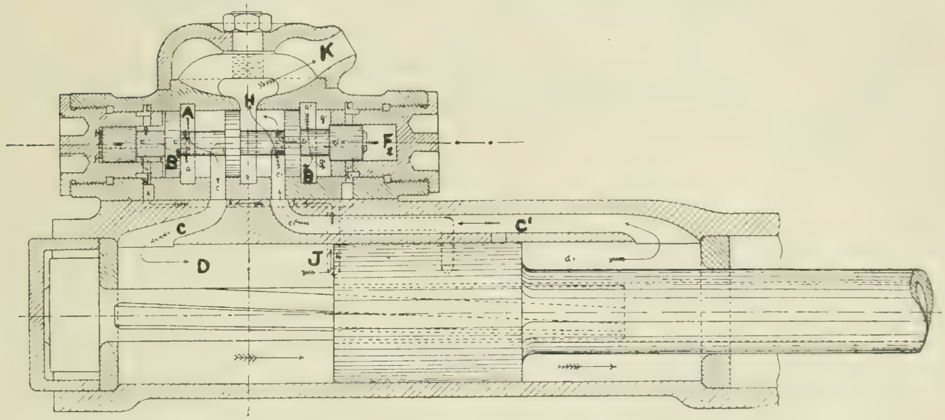


FIG. 5. THE SISKOL DRILL, SHOWING THE SPOOL VALVE.

the same time air from the front of the piston escapes through the port C^1 to the exhaust K, as shown by the arrows. Now the valve is held in this position because live air is pressing on the surface B^1, while at the same time the end of the valve F_2 is connected with the exhaust K through the hole in the valve-spindle. The other end of the valve is also acted on by live air, but as the area here is less than the area at B, the valve is held. But as soon as the piston uncovers the port hole J live air rushes into the space B^1, and as the total area subjected to the live-air pressure here is now greater than at B, the valve is forced over. A similar action takes place on the back stroke. The Sullivan Liteweight, Imperial, Holman cradle-hammer, and other drills use this type of valve.

The Hardy-Simplex hammer-drill (Fig. 6) is much favoured for stone work in British coal and metalliferous mines and in quarrying. It is also being largely used abroad. The action is similar to that of other drills mentioned. The valve is a pressure-operated spool-valve, and owing to its short movement is very economical of air.

THE AUXILIARY VALVE.—This form of valve is to some extent an attempt to combine the outstanding points of the tappet and spool valves. The first drill to adopt auxiliary valve motion was the well known Sergeant machine now manufactured by the Ingersoll-Rand Company. In the Ingersoll-Sergeant drill, as in machines using the tappet valve, the piston is in two sizes. On the forward and on the backward strokes the piston strikes the auxiliary or trigger valve, which consists of a light arc-shaped piece of steel working in a groove and having one end or the other projecting slightly into the cylinder, as shown in the figure (Fig. 7). As the piston raises this trigger valve, a small port is uncovered which allows pressure air to escape from one end of the spool valve, so that the valve is shot over into a position admitting live air into the opposite end of the cylinder from that which had just previously been connected with the pressure supply and putting that end now into communication with the exhaust. Other drills using a similar valve to that described are the Chicago Slogger and the Sullivan Hyspeed.

Another well-known and highly successful drill using this principle is the Holman drill. The arrangement here, however, is sufficiently different from the others to warrant special mention. Two trigger or auxiliary valves are

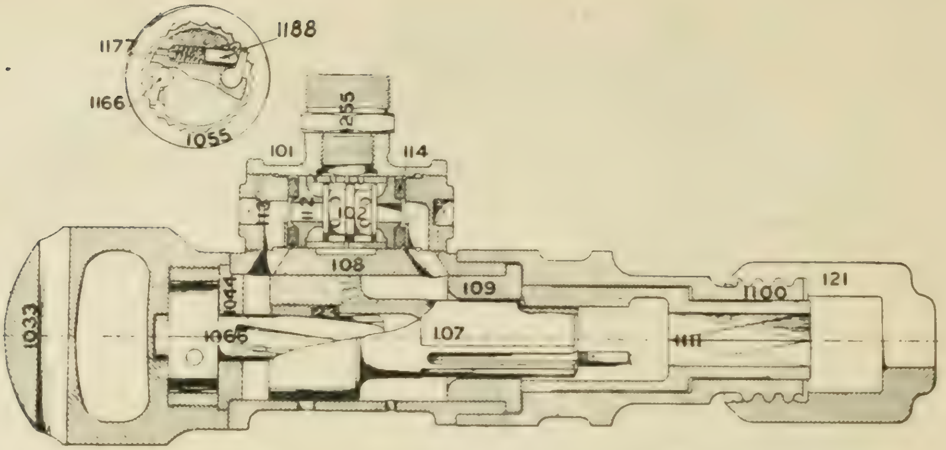


FIG. 6. THE HARDY-SIMPLEX DRILL, SHOWING THE SPOOL VALVE.

used. They consist of steel balls as shown in Fig. 8. The ball valve C is shown lifted off its seat and so allows the air in the end of the valve chest at E to exhaust through the port shown between the upper and lower balls. At the same time the ball D is held down on its seat by the spring, and pressure air entering the valve chest at F pushes the valve over, allows the air to obtain access through the port G to the upper end of the cylinder and air from the lower end of the cylinder to exhaust through the port H. The enlarged parts of the piston operate the ball valves alternately, thus producing reversal of the valve.

THE FLAP VALVE.—The outstanding point about the flap or butterfly valve is its simplicity of design and action. It is employed in the Jackhamer and Leyner-Ingersoll hammer-drills and in some types of piston drills made by the Ingersoll-Rand Company. It is also used in the Meco hammer-drill. The valve consists of a single piece of steel having two wings and oscillating on a central trunnion by the unbalancing of the air pressure on the wings. The action will be clearly understood from Fig. 9 on the opposite page. In the figure live air which enters at S_2 passes to the rear of the piston and forces it forward. At the same time air from the front of the piston escapes at the other wing of the valve at E_1 into the exhaust. When the piston has travelled far enough to uncover the other exhaust port EE_2, live air passes through the latter and acting on the lower wing of the valve balances the pressure on the upper wing. At the same time, however, the exhaust port EE_1 is covered by the piston and the compression of the imprisoned air in front of the piston now throws over the valve. Fig. 10 shows the Jackhamer hammer-drill in which the flap valve is used.

THE BALL VALVE.—This form of valve is used in the Flottmann hammer-drill and also in the Chicago Hummer, Stoper, and Gatling drills. The action will be understood from Fig. 11. The valve consists of a hollow steel ball

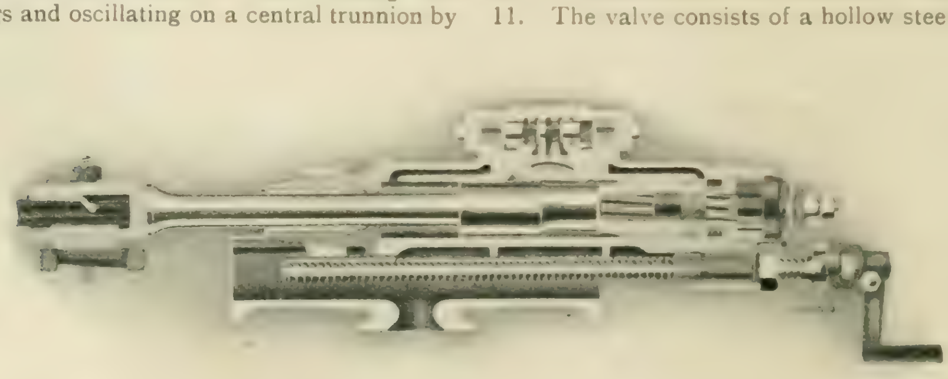


FIG. 7. THE INGERSOLL-SERGEANT DRILL, SHOWING THE AUXILIARY VALVE MOTION.

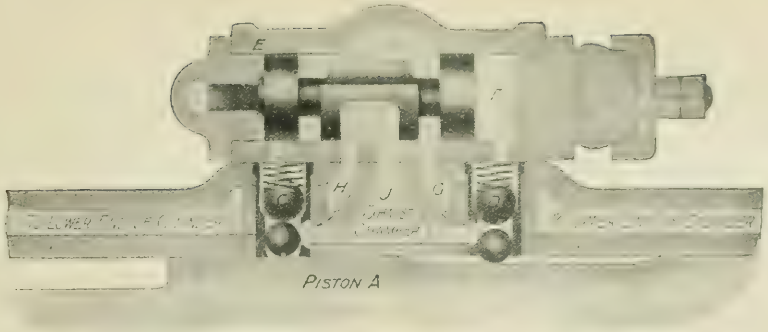


FIG. 8. THE HOLMAN AUXILIARY VALVE.

$\frac{3}{4}$ in. diameter, and is specially hardened and ground. The ball works in a cage or chamber as shown in the figure. The air is obtaining access to the rear of the cylinder as shown by the arrows. This live air also presses on a portion of the surface of the left-hand half of the sphere, but the total pressure tending to force the ball to the right is less than the pressure acting towards the left, since the pressure acts over the whole of the surface of the right-hand half of the sphere. When the piston has moved far enough to uncover the exhaust ports, which are in the cylinder itself, the pressure is suddenly released from the right-hand side of the ball and the valve is shot over against the right-hand port exposing the left-hand port to the entry of live air. On the return stroke of the piston the operation is repeated. The travel of the valve is only $\frac{1}{8}$ in. This form of valve is simple, strong, tight, and not liable to stick. In the Climax Britannia hand hammer-drill a light tubular valve is used instead of a ball-valve.

THE PISTON VALVE.—The piston valve was one of the earliest forms. The Darlington drill, and subsequently the Adelaide, employed this type of valve. They were, how-

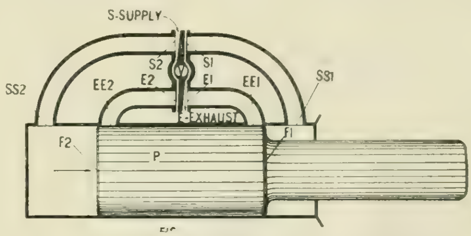


FIG. 9. THE INGERSOLL-RAND BUTTERFLY OR FLAP VALVE.

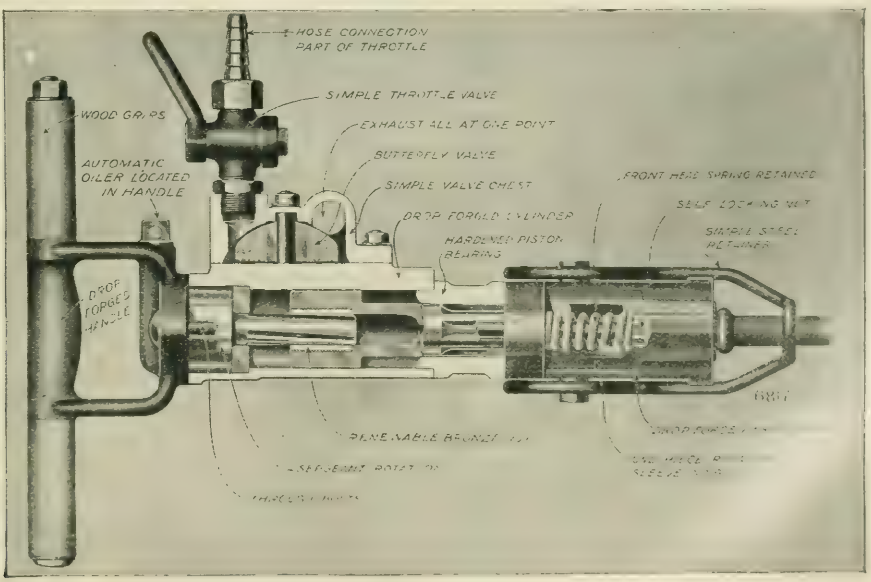


FIG. 10. THE INGERSOLL-RAND JACKHAMER DRILL.

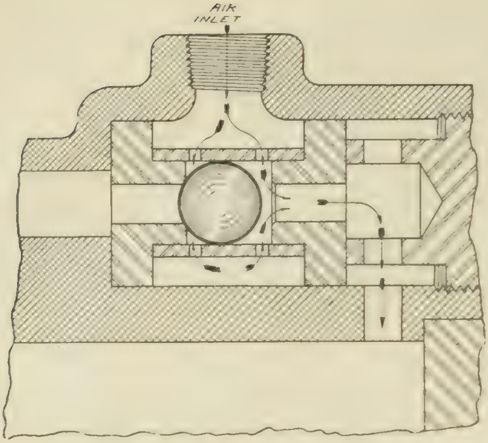


Fig. 11. The Ball Valve.

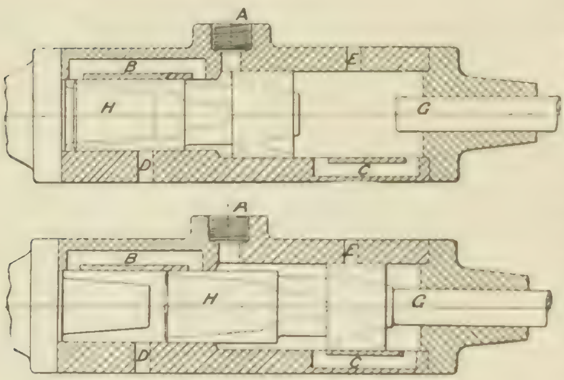


Fig. 12. The Holman Piston Valve.

ever, feeble hitters, and for a time the principle of making the piston its own valve fell into abeyance, to be revived later, however, in the Murphy hammer-drill and in various forms of stoping drills introduced during the last few years. The action is illustrated in Fig. 12, which refers to the Holman valveless stoping drill. The hammer or piston H is constructed in two diameters with a narrower portion between. The pressure air enters at A, fills the space between the two portions of the hammer, and also gets behind the hammer, and the latter is shot forward. After a portion of the distance has been travelled the piston covers the inner end of the port B and the rest of the stroke is completed by the expansion of air behind assisted by the live air acting on the difference in the two diameters of the piston. When the port D is uncovered the air is exhausted. Shortly afterwards the port C is uncovered and pressure air gets to the front of the piston and the return stroke commences. On C being again closed the air works behind the piston expansively and towards the end of the stroke exhausts through E.

THE AIR-FEED DRILL.—This class of drill is a comparatively recent development. It is specially designed for work in the stopes. The forward feed of the drill during boring is performed automatically by the pressure of the supply air on the end of a tube which fits and slides inside another cylinder. (see F, Fig. 2). The operator is thus relieved of the strain and trouble of keeping the drill up to its work. The rotation is by hand. Fig. 2 shows one form of the drill by Holman Brothers. The Climax Company make two forms, the Hydromax and the Hydromite drills, in both of which a waterflush is used.

The Hardy Patent Pick Co., Ltd., has recently introduced a telescopic air-feed hammer-drill specially designed for work in stopes, drifts, and rises. The drill, known as the Water-Jack, is shown in Fig. 13. It possesses several features similar to other drills of the air-feed pattern. The valve is of the air-thrown spool type, and rotation is by hand. An anvil block is interposed between the piston and the drill steel, a feature which is employed in the other air-feed hammer-drills mentioned above. Water is fed under pressure through the anvil and thence through the drill steel to the bottom of the bore-hole. For relatively light work these drills give excellent results.

(To be continued).

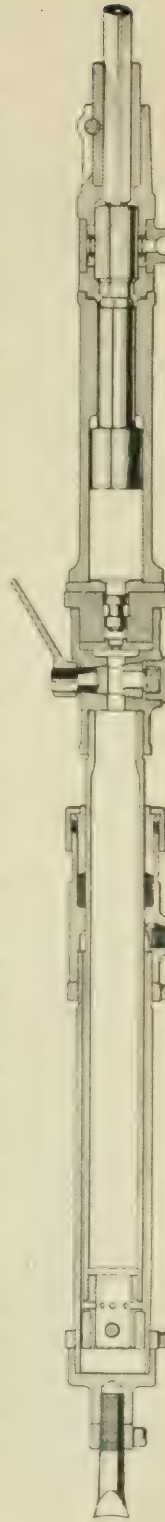


Fig. 13. The Water-Jack Telescopic Air Feed Hammer-Drill.

View of Gull Lake from Tough-Oakes.

THE KIRKLAND LAKE GOLDFIELD.

By H. H. JOHNSON, M.Inst. M.M.

The author, who is visiting the district in the interests of the Kirkland Lake Proprietary, gives his opinion on its prospects.

IN the midst of the general activity which is being manifested in mining development in Northern Ontario, Kirkland Lake stands out prominently in the foreground to-day. To anyone who has not been in close touch with the field during the whole war period, it is certainly surprisingly interesting to see the progress which has taken place in those years of difficulty, due to lack of adequate transport facilities, labour, and stores. It is evident, however, that one factor has never been lacking by those on the spot, and that is confidence.

There is now a continuous stretch of 2½ miles, from the west end of Gull Lake to the west of Kirkland Lake, of gold mines in all stages of active operations, while the width of the belt is expanding to at least half a mile. The properties most concerned at the moment are briefly as follows from east to west: Tough-Oakes, 120 ton mill, developing; Burnside, 30 ton mill, developing; Sylvanite, developing; Black, developing; Ontario Kirkland, developing; Hudson Bay, developing; Wright-Hargreaves, 200 ton mill in preparation, developing; Lake Shore, 60 ton mill, running; Minaker, developing; Teck-Hughes, 100 ton mill, running; Kirkland Porphyry, developing; Kirkland Lake (Beaver) 150 ton mill, running; Elliot-Kirkland, developing. Farther to the west the McIvor is developing, under the auspices of the Lake Shore, and in addition to those mentioned there are a number of properties north and south of them which are being opened up.

The Provincial Government having decided to provide improved means of transport from the railway at Swastika, the local inhabitants were recently asked to state their opinion as to which would meet their requirements best, a branch railway six miles long with two stations and a service of one train a day, or a good macadam road suitable for motor-lorry traffic. The latter was almost unanimously asked, so the Hon. G. H. Ferguson, Minister of Lands, Forests, and Mines, after a personal investigation, promptly authorized its construction at an estimated cost of $75,000, and work has already been commenced. This will undoubtedly prove a great incentive to further work on outlying claims. Judging by the way motor traffic is competing with the railway on short hauls, its flexibility, and facility for delivering freight and passengers to their own doors, it is likely that this road will be the forerunner of a large programme of permanent high-road construction in the North Country.

Like the experience in most mining camps it is becoming apparent that many of the early ideas, amounting almost to dogmas, concerning the occurrence of the ore-bodies have to be considerably modified in the light of actual experience, and it is now possible to form opinions which closely fit the facts.

It is clear that the intrusions of felspar and quartz-porphyry into the sedimentaries have been both the cause of the fracturing and the media from which the mineral-bearing solutions were derived. But there has also been later faulting of considerable magnitude where no appreciable ore deposition has taken place, if one neglects the occasional occurrence of brecciated ore in the fault-filling. This is well illustrated by the so-called east and west mud-seam which has been proved for long distances and has been driven on for hundreds of feet without finding ore. Probably there are several such seams, though it has been commonly assumed that wherever found it is one and the same. Again, the main north and south fault on the Tough-Oakes appears to produce a horizontal displacement of 350 ft., besides a considerable vertical movement, while no gold values are met with on it, nor as a rule in its immediate vicinity.

There has also been a subsequent period of ore deposition to these faults, however, as is proved by veins in some instances going continuously through the faults without displacement. There seems good reason to classify the veins as a whole into two series, an older and younger, the former being perhaps most closely related to the porphyry and generally the richer, although good values are found in both.

So far, development has demonstrated that veins have quite frequently improved in depth, this being particularly the case at the Lake Shore and Kirkland Lake mines, down respectively 400 and 700 ft.; and also that blind veins exist, or at least only outcrop in lakes or swamps where there is no chance of finding them.

It is improbable that individual veins have the continuity of strike that was sometimes claimed for them in earlier days, and certainly the ore occurs in fairly well defined payshoots. On the other hand the old idea of there being one definite line of ore-body is completely disproved by the series of veins found paralleling one another across more than 2,400 ft. of country at fairly close intervals, while over wider gaps encouraging veins are found two miles and more to the north in the Goodfish Lake vicinity.

Mining methods have greatly improved. Settled development policies are being carried out instead of merely applying the original Cobalt method of gouging out high-grade as soon as struck, a method which suited that field at the time quite well. As an instance one might mention the Lake Shore mine, where from 60% to 70% of the mill rock comes from development faces, and the average recovery is about $24 per ton.

The surface plants are uniformly of a high order of substantial design and efficient work. The general practice is stage crushing, ball-milling, tube-milling, and counter-current cyanidation. Electric power has almost entirely superseded steam, the cost of the former being about $50 per h.p. per annum, based on 400 h.p. average load, the load factor being over 70%.

Labour is now quite plentiful and wages are high, and with the rapidly growing town of Kirkland Lake with its organized municipality the district bids fair to be one of the most prosperous in Northern Ontario.

Since Colonel Johnson sent us the foregoing article, his report made for the Kirkland Lake Proprietary Company as to the advisability of effecting an amalgamation with the Tough-Oakes, Burnside, and Sylvanite companies has been published. A brief résumé of the recommendations in this report is given in "Review of Mining," together with an outline map of the properties and their neighbours.—EDITOR.]

THE LAKE SHORE MINE.

FOUR YEARS AS A PRISONER OF WAR

By J. C. FARRANT.

(Continued from the June issue, page 353).

The author continues his account of the treatment of Prisoners of War sent by the Germans to Kurland, Russia.

There were 469 of us in this building at Erbsen Krug, with three flights of stairs and two narrow exits. Fire alarms were practised. Seven minutes was the quickest time recorded for clearing the place. Fortunately a fire never occurred here. There were five carbide lamps, so most of the rooms had none other than home-made lights. These lights consisted of an Oxo tin, a strip of shirt, and dripping. It broke our hearts to burn dripping, but there was no alternative, as candles were unobtainable. We offered to buy carbide lamps, but we were told that there was insufficient carbide. During most of the eighteen months we were in Russia, we were compelled to supply our own light in the manner above described, except when we were at Libau.

January 1, 1917. Temperature zero.* Camp routine: Parade 7 a.m. pitch dark, men worked till 3 p.m., and returned for soup at 4 p.m. The work consisted of building a light railway to connect up the various villages and towns. There was no doctor here, only a German sanität. Serious cases were despatched by sleigh to Libau. This meant a 25 mile drive in an open sleigh to Hasenforth the nearest station.

January 9. Lager III. burnt to the ground; the men lost all their kit and food.

January 10. I made a bet with Jerry Nowland that peace would be signed by January 1, 1918.

January 17. 10° below zero, several men brought back to lager with frost bite.

January 20. Inspecting German Captain came from Libau. Chief Petty Officer Bacon and P. O. Picton-Warlow were ordered in front of the Captain. I went as well to know why the money sent from home six months ago had not reached me. The Captain asked if there were any complaints; a large number of complaints was made. The complaint or rather question which abruptly terminated the interview was the following: Q. Is this a punishment Kommando, as all men who do wrong at Libau are sent here? A. By German military code such a question from a prisoner of war is forbidden. We were then dismissed.

After the Captain's visit a German doctor visited the camp twice weekly. Water for the camp was supplied from a well. The pump was continually breaking down, and on many occasions we were reduced to molten snow for drinking purposes.

January 22. Warmer. 15 degrees of frost. Bisset, of R.N.V.R., Clyde Division, was kicked and struck with bayonet by Dolmetcher M. Bisset had reported sick. M. ordered him to work. Bisset refused and was handled as above. His only "offence" was that he wished to see the doctor. Bisset handed in later a written statement of this affair to the German Lieutenant. Although blood was drawn the the wound was not serious. The general attitude for this German interpreter was such that the camp was in a state of mutiny on January 28 and some of the N.C.O's drafted a letter to the Lieutenant. On January 29 M. was transferred to guard duty, which made life in the lager more tolerable.

February 1. New routine. Reveillé 5 a.m., coffee 5.30., parade 6.15., work 6.30., finish 4 p.m.; men took lunch with them.

February 2. 10 degrees below zero. All men recalled at 10 o'clock, 40 men frost-bitten and some of the guards.

February 3. Fell in one hour later. Whole party recalled at midday on account of cold. Several more cases of frost bites among men and guards.

During the very cold spells it was impossible to work, as the ground was like iron. There were very few guards up in this Godforsaken place, about 1 guard to 35 men, and this shortage of guards was very neatly turned to account. As before mentioned, the work consisted of levelling ground for a light railway, the engineers laying out the line ahead of our working parties. There was a good deal of cutting and filling, but when it came to filling, the men, when opportunity offered, started filling up with lumps of ice and snow covering these with a good layer of earth.

Our men left this region in the spring of 1917, and in the summer when those chunks of ice had melted the greater part of the prisoner of war's work had to be done over again, as the line in that section was more like a miniature switch back. Ever since we had

* The degrees of temperature recorded in these notes have been converted to Fahrenheit scale from the actual Centigrade readings taken by the writer.

been in Russia we worked $6\frac{1}{2}$ days a week, and every Sunday afternoon there was a parade of some kind or other. The Mutiny Act was read by the Lieutenant once a month. The amount of leisure time was confined to the evenings, about 2 hours, as we had to be in bed by 9 p.m. These Sunday afternoon parades were intensely annoying, as it was the only time the men had for washing their clothes. It was all part of the "reprisal."

February 20. Our red-letter day, though we didn't know it until later. The 100 R.N.D. men attached to this Company were told off to pack all their gear. This made our fifteenth move since leaving Döberitz. At 10 a.m. we paraded. Each man received half a loaf to last two days. We were offered uncooked horse lights as well, but we did not accept them, as we still had some food from the parcels sent from home. We set off at 10.30 a.m. Our packs were loaded on sleighs. Three men with frost-bitten toes also rode on sleighs.

We reached lager II. at 5 p.m. where the "mad 500" (British Tommies from Münster lager) were installed. It was bitterly cold in the barn. The thermometer stood at zero on the wall outside, and it wasn't much above inside. Many men walked up and down all night as it was too cold to sleep. I turned in with the sanitäts, who had a stove in their room. In spite of the cold the boys of No. II Company turned out their band and gave us a concert. They played with overcoats and scarves on, and were alternately stamping their feet and blowing on their fingers. The men at this lager had previously had their instruments taken away from them for refusing to play on some German feast-day when requested by the German kommandant. The concert given in our honour was the first since the occasion cited above. This was the first music we had heard since we left Döberitz and we just did appreciate it.

We reached Libau at midnight on Febuary 21. On the 23rd., 20 volunteers were called for to load up packs at the station. I made one of the party. When we arrived at the station we were told off to load provisions and furniture. Among the provisions was a 25 litre jar of rum. As soon as this was loaded in the railway truck a sentry was put in the truck to guard it.

Our party consisted mostly of North Sea fishermen, and they were all old "Gefangs." Two or three of them started an earnest conversation with the guard and English cigarettes were offered and accepted. As soon as one topic was finished another was started. Meanwhile the others were busy with the jar which was in one corner. It was quite dark inside the truck and an empty 5 lb. jam tin was filled not once but many times without detection. Different men engaged the guard in conversation, in order to give each man a fair chance. By the time the guard tumbled to the game several of the party were well "alight," and as we were all to entrain the same evening for Mitau, the question of reporting the matter didn't disturb us.

We returned to the lager about 6.30 p.m. and paraded immediately; at 8 p.m. 600 men left the lager and entrained at Libau. 500 disentrained at Mitau on the next day, while our party of 100 went on to Ekau.

February 25. We marched 17 kilometres in a blizzard, and arrived at Reiskatte at 2 p.m. We entered a barbed wire enclosure in which were two or three dugouts. Over the gate a sign bore the words "Vergeltung Lager" (Reprisal Camp). We were kept on parade for $2\frac{1}{2}$ hours in the snow. New numbers were given us and our kits searched. We were then told to go into the dugouts, and as usual we were overcrowded.

February 26. We paraded at 6 a.m. The lieutenant in charge announced through an interpreter that we 100 men would be sent daily into the trenches to work, as German prisoners of war were employed by the British in their trenches. While they continued to keep German prisoners under shell fire so long should we be kept here. Further a man or men would be shot upon the slightest provocation (geringste Gegenständigkeit). We were then told to write home and state that we were in the German firing line. The lager was about 5 kilometres from the first line.

We were then split into two groups of 40 and 60. The 60 party, which was the day shift, left the lager at 6.15 a.m. Our party of 40 left at 4 p.m. and met the others returning, who said that they had been under fire most of the day but no casualties. We arrived at the third line at 6 p.m., where we were given shovels. A lieutenant addressed our guards, telling them we were on no account to cease working, and rubbing it in that the German prisoners were receiving brutal treatment in the British lines.

The first night's work consisted of shovelling snow out of the third line, which was completely filled. The first lines of German trenches were, in this section, from 50 to 300 yards from the Russian line. The second German trench was 200 yards from the first, and the third trench 200 yards from the second. The place had once been a forest, but shell fire had swept it clean.

We returned to the lager at 3 a.m. tired out. We had been away from the lager 11 hours. The Germans weren't content with this, for the next morning the night party had to do an hour's camp fatigue from 10 to 11 a.m.

March 1. At Point 111/35, 50 yards from first line, 150 yards from Russian line, pulling sleighs loaded with timbers, frequently had to take shelter from machine-gun fire. German soldiers in trenches bore us no malice, and were surprised that we should be working here.

March 2. Our party carrying "bird cages" weighing about 300 lb., two men to a "bird cage," having to carry them 1 kilometre, usually done with five rests. They cut our shoulders, and it was the most straining work I have ever done. These bird cages, as we called them, were about 18 ft. long, and consisted of a 4 in. pole with wooden crosses at each end and one in the centre, round which barbed wire was wound. They were about 5 ft. high, and were used to repair the barbed wire entanglement. We walked 25 kilometres between 4 p.m. and 2.30 a.m., carrying from 6 p.m. till 1 a.m. We had to keep moving to prevent frost bite, but my finger was bitten in spite of that.

March 3. Below zero. We were in the second line, and were stamping our feet for six solid hours. The ground was like iron. We couldn't work. We were supposed to trim off corners and level off the bottom. The guards were dancing up and down as well. They were relieved every two hours. A Russian machine gunner had located us, so we had to keep our heads down.

March 5. Day shift called 5.15. Coffee (for want of a better name as it was made from burnt barley and other stuff) 5.45. Fell in 6.15. Trenches at 8 a.m. Four of us were digging a hole for a rubbish shoot. The picks were blunt, and we didn't pick two barrowfuls all day. Scott, one of the party, was cursing the cold and things in general with vehement bitterness, when his pick fell out of his hands and down he went from exhaustion. I went over to him, but he was motionless. I asked the guard to let us take him into a dugout. He merely shrugged his shoulders and said "Es geht nicht." While I was expostulating with the guard a German N.C.O. came up and he allowed us to take Scott into a dugout where he thawed out. He was helped back to the lager when we returned.

Just after we had taken Scott in, our little party was subjected to about 20 rounds. They were bursting unpleasantly close. The guard was alright, in the lee of a substantial dugout, but we were in the open, but that guard wouldn't let us get shelter until the same N.C.O. came out of a dugout and ordered the guard to take us to an "Unterstand," that is a specially constructed shelter, until the firing was over.

March 7. We were searched for diaries and some were found. We were now beginning to feel the effect of insufficient nourishment as all the food we had brought with us had been eaten. We were strictly on German rations, which were 2/5ths of a 3 lb. loaf per day per man. This was the only solid food we had. Coffee substitute was served at 5.30 a.m., and soup at night. What soup it was! consisting of dried vegetable or pigeon peas, or horse beans. The amount of solids in the soup never amounted to more than two or three spoonsful. Twice a week we were supposed to have meat. The meat was boiled in the copper, but before we drew our soup the solid meat was fished out, and cut up, and divided among the guards. The same graft was carried on with the jam, a large portion being scooped out from our issue for the guards. We never had potatoes.

March 11. (Sunday). We had all looked forward to this day for a rest, and to mend and wash our things, but we were disappointed. We were called at 5 a.m. and were kept shovelling snow till 11 a.m., returned to lager for soup at 4 p.m. We were marched to trenches and worked till 2 a.m., returning to lager at 3.30 a.m., badly done up. One man collapsed. It was the coldest night yet, 10° below zero. From my knees down my legs were numb for 11 hours. We had been working for nearly 20 hours.

March 12. On account of an alleged entry made in C's diary to the effect that we were working sixteen hours a day, the actual working hours were extended as punishment for recording incorrect statements. The guards were lectured and their attitude to us from now on was distinctly hostile, as they had to participate in the longer period.

The actual time at night in the trenches was from 6 p.m. till 2 a.m. No matter if the work was finished or not, one hour pause was allowed. By orders issued we were not allowed in the German dugouts, and to stand in the trenches for an hour without working meant getting frost-bitten. In order to prevent this we worked straight on, but the damned swine wouldn't allow us to leave an hour earlier. So while this bitter weather continued we worked an extra hour. The guards were doing an hour on and an hour off, going to warm dugouts for their stand easy.

(*To be continued*).

NEWS LETTERS.

CAMBORNE.

NATIONALIZATION OF COAL INDUSTRY.—Now that, as anticipated, the Coal Industry Commission has reported in favour of the nationalization of the country's coal industry, it is for the non-ferrous mining industry of the West of England to express a considered opinion as to whether nationalization, if adopted by Parliament, is likely to result in the maintenance, or, as seems probable, in an increase in existing coal prices, with its resultant serious effect on the mining of non-ferrous metals. The Cornish Chamber of Mines took no steps to present evidence before the Commission as to the relation of high coal prices to working costs of the tin mines, although great stress has properly been laid by the representatives of Cornish companies, when the financial results have been laid before the shareholders, of the great burden which the much increased price for coal has involved. This inaction in such an important matter is much to be deplored. A Chamber of Mines is essentially an organization to protect the interests of the mine operator, and no opportunity should be lost in combating all movements which will increase working costs without any offsetting benefit. The same apathy seems likely to prevent the presentation of evidence before the Income Tax Commission, now sitting, as to the present unfairness of the incidence of income tax on mines, a really very important matter to many Cornish mines. However, the point now to be considered is whether the non-ferrous mining industry is likely to be unfavourably affected by the nationalization of the coal industry, and, if so, steps should be at once taken to join in the opposition movement which is now being organized. Soon it may be too late, and then lamentations and protests will be useless. At the time of writing, a further rise in the price of coal is threatened by the coal owners; how it is to be met by most of the mines in Cornwall is a conundrum which it is by no means easy to solve.

There can be little doubt, whatever the fate of the proposal to nationalize the coal industry may be, that the Government will decide on the purchase by the State of the coal royalties of the country, seeing that public opinion generally is in favour of this step. It might now be considered whether it would not be wise to advocate the purchase by the State of all minerals. Much capital has been kept out of the West of England by the onerous and often unreasonable conditions laid down by some of the mineral owners who, not infrequently, are unwilling to take any monetary risks, but insist on a royalty whether the mine is being operated at a profit or not. The substitution of the State for the private owner could—if the people so willed—enable the principle of "no profits, no dues" to be adopted, and some of the iniquitous conditions now insisted on by certain owners to be abolished. Besides, too, the State would be concerned to see its mineral wealth exploited, and might therefore not be indisposed to join financially in drainage and development schemes, as is not unknown in the Colonies. It is a large question, but one which might with advantage be considered jointly by the organizations which represent the metal mines in this country.

TEHIDY MINERALS, LTD.—The statutory report of this company shows that the whole of the 40,000 shares of £1 each offered for public subscription in February last were taken up, and already it appears that a detailed examination of this large and important mineral area, situated in the heart of the Mining Division, has been made by Dr. Malcolm Maclaren, the eminent geologist, and by Mr. W. A. Macleod, who both are much impressed by its great potentialities from the mining standpoint. [See plan in another part of this issue. —EDITOR.] The greater part of the estate has already been extensively mined, and the faith of the engineers is based on the fact that the lodes hitherto worked have, in the main, only been worked in the killas, whereas experience has proved that their mineral content increases in richness in the granite. A recent and excellent illustration of this is shown in the case of the famous Rogers lode at East Pool & Agar, which was poor in the killas. The granite throughout the estate will be met with at a depth not unreasonable for exploitation; the extreme limit is given at 338 fathoms. It is fairly evident that lateral development from shafts now in use and below the bottom of the old workings will be the plan of exploitation adopted; the capital cost of pumping out the accumulation of water makes that method prohibitive. The £40,000 provided will not go far to prove this large area, but there are powerful financial groups behind the company who can doubtless provide the wherewithal if conditions and results so justify.

TIN AND TUNGSTEN RESEARCH. — Recently there was published in the ***Western Morning News*** some correspondence between a Mr. C. G. Bateman and the Research Board, from which it appears that the former claimed to be able to demonstrate a new process or method which would give a much improved extraction of tin and wolfram, but a condition precedent to such demonstration and disclosure of the process was that, if proved successful, he should be paid a "permanent retaining fee of £1,000 per annum and an additional £100 per annum in respect of every one per cent. improvement over 10 per cent. in the increased amount of tin and wolfram concentrates obtained." The Board were unable to agree to this on the ground that "their resources and their work are likely to terminate within a limited period," and they suggested that Mr. Bateman should secure provisional protection by means of patenting his process. This he is not content to do, because he "attaches little value to patents" owing to the costly litigation which a patentee is often involved in to protect his patent. It is, of course, true that a patent is but an invitation to litigation, and it seems a pity that some plan cannot be devised by the Board to guarantee that an inventor shall substantially benefit if his process is really worth adoption. Whether Mr. Bateman's process will do what he claims for it is another story; inventors are usually optimistic people. He definitely states that it is not a flotation process.

STATE AID FOR CORNISH MINES.—The memorandum on this subject prepared by Mr. F. D. Acland, M.P., for submission to the War Cabinet, referred to in the last issue, has now been published, but no new points have been made, except that special emphasis is laid on the "ugly industrial position in West and North Cornwall" likely to be created if something more than the unemployment dole is not provided by the Government. Mr. Acland's principal suggestion is that, pending the long promised inquiry, the Government should provide financial assistance by means of "advances against realizable assets and to taking a definite share in approved development work."

The decision of the Government was communicated by letter dated June 25, 1919: "With reference to the previous communications on the subject of assistance to the Cornish Tin Mining Industry, I am directed by the Board of Trade to inform you that it has now been decided that there shall be an inquiry into the whole position of the Non-Ferrous Mining Industry of the United Kingdom with a view to deciding if the industry can be placed on a satisfactory commercial footing; and that in the meantime, in order to enable mining operations to continue, His Majesty's Government shall make advances to approved mines up to an amount somewhat below the breaking-up value of their plant and machinery as established by independent valuation, such loans to bear interest and to be repayable in a short term of years, and the offer of such advances to be open only until the report of the inquiry has been received and a decision taken thereon. I am to add that the Board of Trade will be glad to receive at an early date applications for such advances. The applications should be in each case for a definite amount and should be accompanied by a detailed statement of the financial position of the applicant company and of the security offered, together with such information as to the condition and prospects of the mine in question as is likely to assist the Board in arriving at a decision. I shall be glad if you will communicate the contents of this letter to the interests concerned." This decision does little to advance matters, because already money can be obtained locally on the security of the break-up value of the machinery.

GEEVOR.—The report of Mr. J. M. Iles on this mine, referred to briefly in the last issue, has now been published, and he states that although he had formed a high opinion of the value of the property on a previous visit, the development since has very much strengthened that opinion, and he records his view that a very small amount of further development will justify increasing the plant for the treatment of a much larger monthly tonnage than the 4,000 tons of ore which the mill now being completed will handle. He figures that by milling 4,000 tons per month, 60 tons of tin concentrate should be produced, and if this result materializes, as appears likely from the value of the ore reserves, then Geevor will rank as the third largest producer in Cornwall.

DEMAND FOR INCREASED WAGES.—The demand for increased wages for all classes of mine employees put forward recently by the Workers' Union can hardly be unexpected, although probably the extent of the increases demanded, particularly those for surface workers, is a matter for surprise. Indeed it is not too much to say that, in the present parlous state of the industry, the demands are absurd, and it is out of the question for the mine-owners to meet them. The officials of the Workers' Union are quite aware of this; they know perfectly well that few mines in Cornwall are even meeting costs, much less earning dividends, and that with tin metal at less than £280 per ton, only abnormally rich or shallow tin mines in the West of England can even "clear their heels" under existing conditions. This being so, one can only assume that this is a move by the Union to force the Government to financially assist the industry to enable higher wages to be paid. It has long been conceded, for instance, that the surface workers are underpaid, taking into consideration the existing cost of living; indeed it will be recalled that the deputation from the Joint Industrial Council, which waited on the Parliamentary Secretary of the Board of Trade on January 30 last, pointed out that the abnormal conditions caused by the war had prevented the worker from being paid a wage adequate to meet the increased cost of living. If this is not the explanation, then it must be assumed that the demands have been drawn with a view to allowing some latitude for a compromise. It is not difficult to foreshadow what will happen if the Union refuses to recede from the position taken up. The mine-owners, being unable to meet the increases demanded, however much they might like to, will refuse, and this will bring about a strike. Industrial strife is about the only thing which will make the present Government move, and so a strike will probably have the effect of hastening the promised inquiry.

To return to the demand of the Union, I set out below a brief summary of the claim:

Rock drillers on development	15s. per shift minimum
Rock drillers on stoping	13s. 6d. ,, ,,
All other classes of underground work	12s. 6d. ,, ,, ,,
All other classes (under 16 years of age)	25s. per week rising to 30s. after one year

In the case of afternoon shifts, five shifts to count as six. Overtime at the rate of time and a half for ordinary days; double time for Sundays and public holidays.

Surface Mechanics	1s. 8d. per hour minimum
Engine drivers	1s. 6d. ,, ,, ,,
All others (men)	1s. 4d. ,, ,, ,,
Boys starting at 14 years of age	18s. per week
Women	30s. ,, ,,
Girls (under 18 years of age)	20s. ,, ,,

Hours of ordinary surface workers to be 44 per week, shift workers 48. Overtime on the same basis as underground workers (see above). Those working continuously running machinery to be paid for all meal hours.

It has been figured in the case of one large mine working in the Camborne district, that these demands equal 7s. per ton of ore milled.

GRENVILLE.—It is understood that this company will shortly be reconstructed, sufficient new capital being provided to pay off the existing bank mortgage, and for the vigorous development of the property. The new manager is Mr. J. Nile.

NORTH OF ENGLAND.

LEAD AND ZINC.—The outlook is no brighter than a month ago. Everything is still in a state of suspense. Consternation prevails. So far the applications that have been made to the Board of Trade have been without result. No answer can be obtained; and the time is fast approaching when the mines will have to close down or run without any assistance whatever to pay the war wages. A number of the mines, I understand, are still waiting on, in the hope that some satisfactory reply may be forthcoming. The Lead and Zinc Mining Association has, in fact, recommended their members to take no irrevocable step. This is undoubtedly sound advice, for, after all, Sir Auckland Geddes on May 30 did definitely promise that the decision of the Government should be communicated to owners. It is true that the anxious inquiries of mine managers have elicited no response. But there is just the chance that no news may be good news. Hope need not be abandoned until it is crushed. What, however, does the Government expect to happen in the industry?

PROFIT-SHARING.—At one of the mines, I understand, a long conference took place between the Union officials and the management concerning a profit-sharing scheme that had been submitted by the owners. The company had been led to believe that the Union would welcome some method of profit-sharing if the basis were such as would not jeopardize the standard rates of pay to which they are apparently determined to adhere come what may. The men seemed to realize that working costs must include a proper charge for depreciation, and the scheme had on the whole a good reception. I have had access to the scheme, which appears to meet any difficulties and objections raised by the Union. It is essential that such a scheme must be distinguished by simplicity, and the scheme of which I write undoubtedly exhibits that feature. The first thing to do is to ascertain the average monthly working costs, which must include wages, materials, carriage, office expenses, royalty, salaries, insurances, and an agreed fixed charge for depreciation, but excluding of course income tax and capital expenditure. After that has to be determined the average monthly revenue from sales of concentrates, excluding rents receivable and interest upon investments. The division of the cost by the average price gives the tons which should be raised to meet the working costs. The actual output is known, and the excess of actual tons of output above the output needed to balance working costs would be profit tons on which £3 per ton would be paid to the men. At the mine in question the charges consist of a wages bill plus all accounts for materials purchased during the month. No monthly stock-taking is carried out because with an average of six months the figures are sufficiently accurate. In the event of especially large purchases of, say, timber, the item is spread over three months in order to avoid violent fluctuations of costs. A bonus of £3 per ton on profit tons would probably suffice to yield the men an increase of anything from 8d. to 1s. 6d. per shift. A question that might be raised is: would it be possible for men working the reduced number of hours per week to get the output necessary to bring profit tons? The merit of the scheme is that it arouses the sporting instinct of the men. Imagine the interest which would be taken in a large chart exhibited at the mine on which are shown two graphs, one representing the tons to meet costs, and the other representing actual outputs. The narrowing of the gap between the two graphs and the gradual overhauling of the profit graph would surely stimulate the workpeople to such exertion as they were never before responsible for. Who that recollects the devices employed to produce record War Loans can doubt that seeing clearly how by the expenditure of extra energy they can benefit themselves the workpeople would have a new interest stirred in their work? It would not necessarily mean, as mine managers well know, that satisfactory results were to be obtained wholly by severe labour. The gap between the two graphs could be decreased partially by the mere act of starting promptly, and working until the expiration of the allotted time. The taking of an intelligent interest in their work would in itself substantially raise the workman's production. And more than this, it lies largely within the power of the men to bring down working costs. How much might not be saved by the care of tools, and economy in the use of explosives and other material? The stoppage of careless waste would play a part in bringing the two graphs nearer the other. How much waste of ore in stopes could not be avoided by men keen on producing profit tons? Every ton lost in cutting fresh ground before every particle of ore in the old ground was recovered, the miners would know, would enlarge the gap. Once get the men interested in the chart, and the efficiency of the mine would mount rapidly nó less in the office, in the dressing department, in the fitters' and blacksmiths' shops, than in the workings of the mine. For all about the place would participate in the profit-sharing, from the clerk to the miner. Once the benefits began to be derived it is improbable that the workmen themselves would tolerate slackness on the part of any of their fellows. The author of this scheme would like the foremen to have double bonus, and he is even sanguine that if adopted and proved sound and satisfactory, it might lead eventually to the extinction of contracts. This letting of contracts is a hopeless system. It leads to endless friction, and resolves itself mainly into prolonged haggling over terms which engenders friction and breeds suspicion. One strong point about the scheme is that it settles all dispute about the price of metal. As the price goes up fewer tons are needed to raise the output above the profit-ton line; as the price falls a greater production must be forthcoming for the bonus to be earned. I hope to give details of the scheme in a later report.

TORONTO.

June 12.

LABOUR TROUBLES.—The general feeling of unrest and dissatisfaction prevalent among the working men of Canada, which has resulted in protracted strikes in Toronto, Winnipeg, and other cities, has affected the mining camps of Northern Ontario. Demands for increased pay, shorter hours, and recognition of the Union have been made by the miners at Porcupine, Cobalt, and Kirkland Lake, and refused by the companies, and a strike at the two latter districts is likely to take place very shortly. Many of the mines are making preparations to close down.

METALLIFEROUS PRODUCTION OF ONTARIO. — Returns received by the Ontario Bureau of Mines for the three months ended March 31 show a decrease in the value of metalliferous production, which amounted to \$10,182,479 as compared with \$14,297,905 for the corresponding period of 1918. The principal decline was in nickel and copper in matte, the value of the former being \$2,692,800, as compared with \$5,806,200, and the value of copper in matte being \$588,280, as against \$1,748,990 for the first quarter of 1918. Silver production shows a decrease in value from \$3,152,700 to \$3,740,843, and the output of gold a drop from \$2,265,521 to \$2,026,536.

PORCUPINE.—Progress at the Dome Mines is handicapped by labour difficulties, and owing to the shortage in the working force the mill is only treating about 600 tons of ore daily. The cost of operations is about 30% higher than before the war, being about \$3·35 per ton. Development work on the Dome Extension property, which is being worked under option, has placed a large body of ore in sight, stated to assay over $5 per ton. The Hollinger Consolidated has announced another dividend of 1%, making the third disbursement this year. In view of steadily improving conditions and an increasing output, it is expected that the payment of 1% dividends every four weeks will shortly be resumed. At the McIntyre the main shaft is being continued to the depth of 1,375 ft., where another main haulage will be established. An intermediate level is being run between this and the 1,000 ft. level. When these workings have been completed the shaft will be sunk further. Recent finds have added considerably to the ore reserves. About 15,000 tons monthly is being treated, of an average grade of $10 to the ton. A mining plant is being installed at the Clifton - Porcupine, a short distance from the Dome. The Davidson is now on a regular producing basis, the small mill working at capacity with mill-heads averaging $20 per ton. The ore-body at the 500 ft. level has been driven on for 75 ft., the high grade of the ore being well maintained. A winze is being sunk from the 500 ft. level to open up a large body of ore on the 700 ft. level. The Dome Lake mill is treating high-grade ore from a large lens on the 600 ft. level.

KIRKLAND LAKE.—The Lake Shore during April treated 1,800 tons of ore for a yield of $44,781, being an average of $24·88 per ton. The Tough-Oakes has developed an ore reserve sufficient to keep the mill in operation for half a year. Development work will be steadily continued, and the mill will not be put in operation until later in the season. The Wright-Hargreaves is making good progress with the construction of a 200 ton mill, which will be the largest in the district, and is expected to be ready for operation in the autumn. The Teck-Hughes during April produced gold to the amount of $27,216 from the treatment of 2,602 tons of ore, the average gold content being $10·46 per ton. Mining has been resumed on the Hohenaur property adjoining the Kirkland-Porphyry. At the Ontario-Kirkland, vein No. 1, which dropped out of the shaft at a depth of 190 ft., has been cross-cut at the 300 ft. level where it shows a width of 5 ft. The shareholders of the Canadian Kirkland have ratified an agreement giving a controlling interest to the Crown Reserve of Cobalt. The Berry claims, comprising about 200 acres near the Burnside, have been optioned to interests associated with the McIntyre of Porcupine.

COBALT.—The Nipissing, during May, produced ore of an estimated net value of $347,751, and shipped bullion from Nipissing and custom ores of an estimated net value of $102,578. Underground work during the month was attended with satisfactory results. Veins 99 and 109, each about 2 in. wide, on being opened up showed ore containing over 5,000 oz. silver to the ton. The Mining Corporation of Canada has suspended work on its property in the south-eastern part of Bucke Township. Three veins were cross-cut at 300 ft., but commercial values were not encountered. The Temiskaming has taken an option on the Cochrane property adjoining, and agrees to spend $3,500 per month in development. The Northern Customs Concentration has leased the Silver Cliff property, and is taking out low-grade ore. A high-grade vein has been found on the surface on the Faragh property. The management of the McKinley-Darragh is arranging to carry on extensive explorations in the south-eastern part of the property. The Nipissing has dropped its option on the Ophir mine.

BOSTON CREEK.—At the Miller Independence a vein containing 16 ft. of high-grade ore has been cross-cut at the 100 ft. level. Equipment for a large reduction plant has been ordered, and contracts have been let for clearing a right of way for the power line.

MATACHEWAN.—This field, which is attracting much attention, is to be provided with electric power by the development of Matachewan Falls, six miles to the north. The falls have a nearly vertical drop of 41 ft. At the Matachewan mine, formerly the Otisse, a rich lens of ore showing visible gold has been found between the 50 and 100 ft. levels. A group of claims lying north-east of the Matachewan are to to developed by a company under the name of the Matachewan-Rand Gold Mines.

LETTERS TO THE EDITOR

Spitsbergen.

The Editor:

Sir—As a Swedish mining geologist who has spent two summers in Spitsbergen, allow me to send you a criticism of the projects of the Northern Exploration Company, an English company that has much advertised its iron and marble properties.

In one of the pamphlets issued by this company, entitled "Spitsbergen's Mineral Wealth, its Vital Importance to British Trade and Industry" (also appearing as a series of articles in *The Financier*, October and November, 1918), Mr. Mangham, of the Northern Exploration Co., expresses his conviction (p. 16) "that the famous Swedish iron mountain at Gellivare was outclassed by the Northern Exploration Company's iron mountain at Recherche Bay, Spitsbergen, without reckoning the further immense deposits believed to exist in the related ranges. Prior to the discovery of the Recherche Bay mountain the Swedish mountain was admitted to contain the largest and richest deposits of magnetite known, but it was *dwarfed** by the Spitsbergen iron deposits of the Northern Exploration Co. The Recherche Bay mountain is about 12 English miles long against the Gellivare mountain's length $3\frac{1}{4}$ miles; has a breadth of three miles and a height of 1,400 ft. against 525 ft." . . . and (p. 22) : "If we promptly avail ourselves of the magnificent resources Spitsbergen now offers—and no hitherto undeveloped region of the world can compare with it in respect of ore abundance, high - grade quality, cheap production, and easy transport—we shall not only hold our own against all rivalry, but we may regain the former ascendency of our iron and steel industry over European, if not American, competitors. If, on the other hand, we neglect that opportunity we may imperil our future as an industrial nation" . . . also (p. 37) "it is indeed doubtful if these deposits can be paralleled in the whole world."

So the pamphlet runs; they are brave words, which could hardly be "dwarfed," but not exactly the words of an expert or a responsible company.

Now, I happen to know the results of detailed reports on the same deposits, made from 1912 to 1916 by three iron experts, one Norwegian and two Swedish mining engineers of repute, and their conclusions could certainly not be more disconcerting to the reader of the pamphlet, for they all independently come to the conclusion that the iron deposits at Recherche Bay are of no value and that, even with the most favourable position as to mining and market conditions, the deposits could not be worked. The last examination was made by a Swedish engineer in 1916; he spent one entire summer on a thorough examination of the Recherche Bay deposits, and his results were, if possible, even more disheartening than those of the earlier engineers. Although the predominant constituent of the iron minerals present is magnetite, the "ore-body" had no effect on the magnetic needle unless the needle was placed directly on the mineralized part of the rock; while the amount of ore present was so insignificant that it was impossible for the engineer to collect a proper sample for a milling test.

The mountain alluded to in the reports of the Northern Exploration Co. does not consist of iron ore, but of dolomite of Cambrian-Silurian age, which is intercalated with thin stripes and bands of quartzite. The ore, which is a very pure magnetite and hematite, mostly the former, is found as thin covers on the cleavage planes of the quartzite, and as small vein fillings that only at one place—and very locally—reached a thickness of half a metre, mostly only a few centimetres. The fragments and boulders of quartzite, being covered with this thin film of iron minerals, may lead to the false conclusion that large quantities of ore are present; by breaking the stones, however, the barren rock appears.

This, then, is the iron mountain of the Northern Exploration Company on Spitsbergen, the mountain that "outclasses the famous Gellivare mountain in Sweden and that hardly can be paralleled in the whole world."

No one knows the mineral deposits of Spitsbergen better than the Norwegian geologists and mining engineers, who for the last 13 years continuously and systematically have carried out the exploration of the entire west and north of Spitsbergen. Such phrases, as are to be found in the reports of the Northern Exploration Co. regarding the mineral wealth of the islands, as (p. 7) "The abundance and diversity of minerals there is probably unparalleled in any area of like extent on the face of the globe" . . . (p. 19) "Spitsbergen simply teems with mineral wealth . . . There are no fewer than 16 minerals on the properties of the Northern Exploration Company . . . Probably no equivalent area in the whole world can compare with west Spitsbergen for the abundance and diversity of its mineral wealth," etc.—such phrases, I say, are, to put it mildly, utterly astonishing to us, who not only have traversed the coast-lands of Spitsbergen everywhere, and mapped it topographically and geologically, but also the inland plateaus in every direction.

Far from being rich on ores and minerals, Spitsbergen is—excepting the coal deposits—rather poorly supplied with mineral wealth.

The Northern Exploration Company also mentions guano deposits in Horn Sound, stretching 5 miles inland. In 1917 and 1918 three Norwegian geologists, together with their topographical surveyors, traversed every corner of the land surrounding Horn Sound, and they found — well — some birds' excrement here and there, as such material usually is, on

* The italics are mine.—R.M.

the rocks on the north side of the bay.

Personally I have, during my two summers stay on Spitsbergen, had the occasion to examine the so much advertised marble deposits of the Northern Exploration Company at King's Bay. The stone, which is a brecciated limestone, cemented with calcite veins, takes a beautiful polish and has beautiful colours, but it is so scattered and broken throughout the deposit that it is useless for anything else than very small articles.

There are a considerable number of other statements in the company's reports and pamphlets that could be criticized and controverted, but the above is sufficient.

ROLF MARSTRANDER.

Kulhuset, Telemarken, Norway,
June 2.

The Editor:

Sir—There has been a good deal of controversy lately about the mineral wealth of Spitsbergen, and a brief recapitulation of a paper read by Mr. Adolf Hoel at a recent sitting of the Norwegian Geological Society may be of interest to you. The paper was entitled: "The Coal and Ore Deposits of Spitsbergen, their Economic Value and their Distribution among Different Nations."

The author of the paper is probably the greatest authority on the geology of Spitsbergen. He was formerly a Government Geologist, but has since entered private service, and he has spent the last ten or twelve seasons on Spitsbergen, occupied with exploration work.

Speaking of the much discussed iron-ore deposits, Mr. Hoel stated that as early as 1909 he had come across numerous pebbles of magnetite and hematite in a moraine on Prince Charles Headland. Such stones have since been found at numerous points along the west coast. Mr. Hoel succeeded in identifying the nature of the formation accompanying the iron ores, and this formation has been ascertained in a narrow strip at various localities near the coast. All deposits hitherto found—with the possible exception of that on Prince Charles Headland—are, however, too poor for exploitation.

The iron-ore deposits north of Bell Sound and on Martin's Range (or Iron Mountain) near Recherche Bay have been closely examined at different times by a Norwegian and two Swedish experts, and have been proved to be without the least economic value. The ore is very pure, but it occurs in quite narrow streamers seldom attaining a width of 1 ft. In places a number of streamers run parallel, but the iron contents of the entire mass are in all cases so low as to exclude the idea of an exploitation. The ore consists almost entirely of magnetite, yet the deposit does not influence the magnetometer.

The accessible parts of Spitsbergen have by now been fairly well explored, yet no ore deposits of any importance have been discovered.

The exploitation of other minerals—excepting coal—has hitherto likewise proved disappointing. The Spitsbergen marble, on which a great amount of money has been spent, is too friable and quite useless for architectural purposes. Several hundred tons of phosphorite and gypsum from deposits near Cape Thorsen (Icefjord) have been shipped to Norway. The former proved of too low a grade to pay. The gypsum is being tested at cement works. An asbestos deposit of some extent has been worked for two seasons near Recherche Bay, but no spinning-fibre has been produced.

I will not dwell on Mr. Hoel's description of the well-known coal deposits. The seams worked occur in the Tertiary formation. They are of great extent and regularity, and the value of the properties varies as they are more or less favourably situated for transport and shipping. The largest and most valuable properties are held by Norwegian companies who in 1918 shipped 55,000 tons of coal, employing 600 workmen. In the same year 4,000 tons was shipped from Swedish-owned properties (100 employees), and 2,500 tons from mines in Russian possession (40 employees). English companies employed 50 workmen, but exported no coal.

Mr. Hoel pointed out that the scientific exploration of the country is mainly due to Norwegian enterprise. Thus 64 Norwegian expeditions of a wholly or partly scientific character have visited Spitsbergen within the last hundred years, beginning with Professor Keilhan's expedition in 1827. Besides, the majority of foreign expeditions sailed on Norwegian ships and with Norwegian crews and generally with Norwegian members on the staff. Almost all men employed in the mines at present are Norwegians.

The present political status of Spitsbergen as "terra nullius" seems impracticable in face of the growing industrialization of the country, and a more definite arrangement is looked upon as inevitable. From the reasons stated above, and considering the geographical position of the Island, there is a strong feeling here that Norway has the first claim to Spitsbergen.

R. H. BLUMENTAL.

Kristiania, May 29.

PERSONAL.

A. H. ACKERMANN has left for Transylvania.

SIR FREDERICK BLACK, the Government's representative on the board of the Anglo-Persian Oil Co., has been appointed a managing director of the company.

G. W. CAMPION is here from West Africa.

F. C. CANN is expected from Queensland.

FRANK CARROLL, representing the Ingersoll Rand Co., has been visiting Australia.

A. G. N. CHALMERS, son of George Chalmers, superintendent, has been appointed assistant superintendent for the St. John del Rey Company.

W. R. DEGENHARDT is home from Burma.

F. JULIUS FOHS, an American oil engineer, has passed through London to Palestine, where he will make investigations for the Zionist Organization of America.

ARTHUR W. EASTLAKE and WILLIAM SUTTON, who were for many years associated with the late Sir Boverton Redwood, have entered into partnership. Robert Redwood will co-operate with them in connection with the examination of oil samples, and W. H. Dalton in connection with geological matters.

J. JERVIS GARRARD is here from South Africa.

A. GERNET has left for Russia.

A. GOLDWATER is expected from Nigeria.

H. D. GRIFFITHS has left for Burma.

R. G. HALL is here from Burma.

SIR THOMAS H. HOLLAND is on his way home from India.

LT.-COL. A. C. HOWARD, D.S.O., M.C., late of the R.E. 41st Division, has been demobilized, and is now in Spain.

AUSTIN Y. HOY is back from the United States.

J. G. LAWN is here from South Africa.

DR. MALCOLM MACLAREN has left for Bucharest.

T. BRUCE MARRIOTT has returned from South America.

L. J. MAYREIS is here from Burma.

F. P. MENNELL has been visiting the newly-discovered tinfields of Portuguese East Africa.

ARTHUR H. P. MOLINE, superintendent of Bendigo Amalgamated, has been appointed general manager. E. C. DYASON has resigned as managing director, but retains his seat on the board.

WILLIAM NEILL, manager for the Cassel Cyanide Co., has been visiting the United States, Canada, and Mexico.

C. E. PARGETER has gone to Abu, Egypt.

FLOYD W. PARSONS, editor of *Coal Age*, has been appointed to the editorial staff of the New York *Saturday Evening Post*, which has recently started a business and science section.

W. PELLEW-HARVEY is home from Australia.

WALLINGTON A. POPE has gone to Nigeria as manager of the Dua property.

G. E. STEPHENSON has returned from Egypt and will be leaving shortly for New Zealand.

E. O. TEALE is here from the Gold Coast.

W. E. THOMAS has moved his office to 6, Drapers Gardens, London, E.C.

SCOTT TURNER has been appointed consulting engineer to the Mining Corporation of Canada. His office is at the Bank of Hamilton Building, Toronto.

EDWARD WALKER has been on holiday in the Isle of Wight.

A. B. WATSON has returned from Nigeria.

J. P. B. WEBSTER has returned from Siberia.

LT.-COL. H. H. YUILL, D.S.O., M.C., late Controller of Mines, First Army, B.E.F., has joined the firm of Bainbridge, Seymour & Co., Ltd. Col. Yuill is M.Sc. of McGill University, Montreal.

Two medals of the Institution of Mining Engineers have been awarded this year, to DR. AUGUSTE RATEAU and VICTOR WATTEYNE respectively.

The John Fritz Medal has been awarded to GENERAL G. W. GOETHALS, the builder of the Panama Canal.

TRADE PARAGRAPHS

THE IRON & COAL TRADES REVIEW, of which Harold Jeans, A.R.S.M., is editor, has moved its offices from 165, Strand, to Bessemer House, Duke Street, Adelphi, London, W.C.2.

JOHN BROWNING, 146, Strand, London, W.C.2., send us catalogues of petrological and metallurgical microscopes, and of spectroscopes and spectrometers. The firm also deal in second-hand instruments, and issue lists of such as are on sale.

THE INDIA RUBBER, GUTTA PERCHA, & TELEGRAPH WORKS CO., LTD., of Silvertown, London, E., send us a pamphlet describing the wide scope of their manufactures. Mining men will be interested in their conveyor-belts, rock-drill hose, and golf balls.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO., LTD., of Cambridge, send list No. 191, dealing with thermo-couple potentiometers. These potentiometers are particularly intended for use in checking thermo-couple pyrometers. They are made in two patterns, suitable respectively for workshop and laboratory use.

JAMES KEITH & BLACKMAN CO., LTD., of 27, Farringdon Avenue, London, E.C.4, send us list V97 just issued dealing with small electric blowing fans such as are suitable for smith's forges. Particulars are also given of small exhaust fans intended for removing smoke and fumes furnaces of various descriptions

CHALMERS & WILLIAMS, Chicago Heights, Illinois, send us a leaflet describing their various machines for comminuting ore : stamp-mills, gyratory crushers, jaw-breakers, crushing rolls, tube-mills, ball-mills, Huntington mills, and Symons disc crushers. Forty 48 in. Symons crushers are in use at Chuquicamata, and eighteen at the Ajo mine, Arizona.

THE OLIVER CONTINUOUS FILTER CO., of San Francisco, reports that the American Smelters Securities Co. has recently purchased for the Veta Grande mill at Parral, Chihuahua, six 12 ft. diameter by 16 ft. Oliver filters with complete vacuum equipment. The mill capacity is being increased to 600 tons per day. Sales of similar equipment have been made to the Benguet Consolidated Mines at Benguet, Philippine Islands, and to the Government cyanide plant in the Dutch East Indies.

THE NORTON COMPANY, of Worcester, Massachusetts, has recently secured the English rights to the trade-mark "alundum," the aluminous product for which it is noted. The company has issued its 1919 edition of refractories. It contains many additions, including an extensive range of sizes of tubes, muffles, and cores, as well as newly developed shapes and a new product known as "electrically sintered magnesia." Prices are given of the various products. A number of tables and charts and a complete bibliography of alundum snd crystolon refractories have been included. These make it useful as a reference book in connection with high temperature electric furnace products

ADAM HILGER, LTD., 75A, Camden Road, London, N.W.1, send us a pamphlet describing the latest improvements in their spectrometers. The instruments described are : (*a*) A Lummer-Gehrcke Parallel Plate, (*b*) A Fabry & Perot Etalon, (*c*) A Michelson Echelon Diffraction Grating. They are designed to be suitable

DAILY LONDON METAL PRICES: OFFICIAL CLOSING PRICES ON
Copper, Lead, Zinc, and Tin per Long Tons; Silver

	Silver	Copper				Lead
		Standard Cash	Standard (3 mos.)	Electrolytic	Best Selected	Soft Foreign
June	d.	£ s. d. £ s. d	£ s. d. £ s. d.	£ s. d. £ s d	£ s. d. £ s. d	£ s. d. £ s. d.
11	54¼	79 10 0 to 79 15 0	80 5 0 to 80 10 0	83 0 0 to 84 0 0	83 0 0 to 84 0 0	22 5 0 to 22 10 0
12	54¾	80 0 0 to 80 5 0	80 12 6 to 80 17 6	83 10 0 to 84 0 0	83 0 0 to 84 0 0	22 10 0 to 22 15 0
13	54	81 12 6 to 81 17 6	82 7 6 to 82 12 6	85 10 0 to 86 0 0	85 0 0 to 85 0 0	22 15 0 to 23 0 0
16	54¼	82 15 0 to 83 5 0	83 10 0 to 83 15 0	86 0 0 to 88 0 0	85 0 0 to 86 0 0	23 5 6 to 23 7 6
17	54⅞	82 2 6 to 82 7 6	82 17 6 to 83 2 6	86 0 0 to 88 0 0	85 10 0 to 86 10 0	22 17 6 to 23 2 6
18	54⅞	83 15 0 to 84 0 0	84 10 0 to 84 15 0	86 10 0 to 88 10 0	85 10 0 to 86 10 0	22 17 6 to 23 2 6
19	54¾	84 5 0 to 84 10 0	85 0 0 to 85 5 0	86 10 0 to 88 10 0	85 10 0 to 86 10 0	22 17 6 to 22 12 6
20	54¼	86 5 0 to 86 10 0	87 5 0 to 87 10 0	89 0 0 to 92 0 0	88 0 0 to 90 0 0	22 15 0 to 22 10 0
23	53¼	86 7 6 to 86 12 6	87 7 6 to 87 12 6	89 0 0 to 92 0 0	88 0 0 to 90 0 0	22 10 0 to 22 5 0
24	54$\frac{1}{16}$	88 0 0 to 88 5 0	88 15 0 to 89 0 0	90 0 0 to 93 0 0	89 0 0 to 91 0 0	22 10 0 to 22 5 0
25	54$\frac{1}{16}$	87 0 0 to 87 5 0	88 0 0 to 88 10 0	90 0 0 to 93 0 0	89 0 0 to 91 0 0	22 0 0 to 22 5 0
26	53¾	86 7 6 to 86 12 6	87 10 0 to 87 15 0	90 0 0 to 93 0 0	89 0 0 to 91 0 0	22 2 6 to 22 5 0
27	53¼	87 5 0 to 87 10 0	88 5 0 to 88 10 0	91 0 0 to 93 0 0	90 0 0 to 91 0 0	22 2 6 to 22 5 0
30	53	86 15 0 to 87 0 0	88 0 0 to 88 5 0	91 0 0 to 93 0 0	90 0 0 to 91 0 0	22 7 6 to 22 10 0
July						
1	—	87 5 0 to 87 10 0	88 5 0 to 88 10 0	91 0 0 to 95 0 0	90 0 0 to 91 0 0	22 5 0 to 22 7 6
2	53	89 0 0 to 89 5 0	90 0 0 to 90 5 0	92 0 0 to 97 0 0	90 0 0 to 91 0 0	22 10 0 to 22 15 0
3	53¾	91 5 0 to 91 10 0	92 5 0 to 92 10 0	94 0 0 to 99 0 0	90 0 0 to 91 0 0	22 12 6 to 22 17 6
4	53½	91 10 0 to 91 15 0	92 10 0 to 92 15 0	95 0 0 to 99 0 0	94 0 0 to 95 0 0	22 10 0 to 22 15 0
7	53¾	94 0 0 to 94 5 0	95 0 0 to 95 5 0	96 0 0 to 101 0 0	94 0 0 to 95 0 0	22 15 0 to 23 0 0
8	53$\frac{11}{16}$	95 0 0 to 95 5 0	96 0 0 to 96 5 0	97 0 0 to 102 0 0	96 0 0 to 97 0 0	23 0 0 to 23 2 6
9	53$\frac{11}{16}$	97 10 0 to 97 15 0	98 10 0 to 98 15 0	100 0 0 to 105 0 0	96 0 0 to 97 0 0	23 10 0 to 23 17 6
10	53½	95 10 0 to 96 0 0	96 10 0 to 97 0 0	100 0 0 to 105 0 0	96 0 0 to 97 0 0	23 12 6 to 23 17 6

for use on the modified form of Hilger Wavelength Spectrometer (Constant Deviation Type). Thus applied, the Fabry & Perot Etalon affords a means of determining wavelengths to a very high accuracy; while either the Echelon or the Lummer-Gehrcke Plate will demonstrate the Zeeman effect, the effect of pressure on the lines of the spectrum, or the minute structure of any desired lines, with a minimum of trouble and with the great intensity of light that distinguishes these powerful devices for high resolving power. At the same time the wavelengths of the lines under observation can be read off direct from the drum of the Wavelength Spectroscope. The mode of application to the Wavelength Spectrometer has the further great advantage that a large number of the lines of the spectrum can be examined at one and the same time, all the lines which are visible in the eyepiece being simultaneously subjected to the analysis of the Lumber Plate, of the Fabry & Perot Etalon, or of the Echelon, as the case may be. Fabry & Perot Etalon is constructed with a distance piece consisting of a hollow cyclinder of fused silica between the plates.

METAL MARKETS

COPPER.—The feature of the situation during June was the important upward movement in the price of the metal. This has chiefly emanated from America, where a considerable advance has taken place, amounting to about 2c. per lb. during the period in question. While the start of this rise seemed to have been largely in sympathy with Wall Street movements, which stimulated some speculative interest in the metal, it has been carried further by considerable purchases of copper by the ultimate consumers in that country. The market here has moved in sympathy, and it is believed also by a little assistance in the shape of support to the standard market in London by American interests. At all events, the standard market has been active, the aggregate transactions having considerably increased, while the turnover occasionally amounted to as much as 1,000 tons in a day. Values have risen substantially, the improvement amounting to £8 in the case of cash metal, and £9 for three months. Electrolytic copper also went up in price on this side to the extent of about £9. 10s. per ton. A good demand has been experienced from consuming trades in this country, and the fact that most of the inquiry since the conclusion of hostilities has been for copper in the shape of wire bars, rather than ingot bars, has depleted the stocks of wire bars in this country, while even for shipment from America a considerable premium is asked for that description. In manufactured copper a good inquiry has also been seen, in which India has largely participated. An interesting development is the reported offering of American copper and yellow metal to India.

The average price of cash standard copper in June 1919, was £[illegible]; May 1919, £77. 16s. 8d.; June 1918, £110 5s.; May 1918, £110 5s.

TIN.—The past month has seen a moderate amount of activity in the standard market, which has, roughly, fluctuated from slightly over £230 to a little over £240 per ton for cash metal. The close at the end of May was at £232. 7s. 6d. for cash. From this level values improved until on June 19 cash standard stood at £243 5s. Subsequently values reacted somewhat until the end of the month when cash metal stood at £238. 5s. and three months at £236. 5s. A satisfactory feature of the situation has been the continuation of business in Eastern markets. Prices there have occasionally approximated the parity of values here, but latterly have shown a tendency to keep rather above this market, which seems to be attributable to the demand in that quarter for direct shipment to the United States. An item of considerable interest to the tin market generally was the announcement of the raising of the import embargo in America as from the end of June. This was first announced as applying to tin ore and concentrates, but latterly the metal itself was added. It seems to be generally understood, however, that it is improbable that permission will actually be given to import any metal into that country before the end of July. This is presumably to put all buyers on a similar footing, so that those who have accumulated metal near at hand, such as in Canada, will not be put in a more favourable position than those who have to await shipment from the East. It will also, no doubt, give the American smelters an opportunity to dispose of some of the metal accumulated owing to their having withheld from the market to assist the Government in disposing of their stocks. Business in this country has only been on a moderate scale, the South Wales tin-

THE LONDON METAL EXCHANGE.
per Standard Ounce.

Zinc (Spelter)						Standard Tin Cash						Standard Tin 3 mos.					
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
36	5	0 to	36	15	0	236	10	0 to	236	15	0	2 2	15	0 to	233	0	0
36	5	0 to	36	15	0	237	0	0 to	237	10	0	233	5	0 to	233	10	0
36	10	0 to	37	0	0	238	0	0 to	238	10	0	235	0	0 to	235	10	0
36	10	0 to	37	0	0	241	5	0 to	241	15	0	237	10	0 to	238	0	0
36	10	0 to	37	0	0	239	10	0 to	240	0	0	235	10	0 to	236	0	0
36	10	0 to	37	0	0	242	10	0 to	243	0	0	238	0	0 to	238	10	0
36	10	0 to	37	0	0	243	0	0 to	243	0	0	239	0	0 to	239	10	0
37	5	0 to	37	15	0	242	15	0 to	243	10	0	238	15	0 to	239	0	0
37	10	0 to	37	15	0	239	0	0 to	240	0	0	235	15	0 to	236	0	0
38	5	0 to	38	15	0	240	10	0 to	241	0	0	237	0	0 to	237	10	0
38	5	0 to	38	15	0	242	0	0 to	242	10	0	238	0	0 to	238	10	0
38	5	0 to	38	15	0	239	5	0 to	239	15	0	236	0	0 to	236	5	0
38	10	0 to	39	0	0	238	5	0 to	238	15	0	235	5	0 to	235	15	0
38	15	0 to	39	5	0	238	0	0 to	238	10	0	236	0	0 to	236	10	0
39	0	0 to	39	7	6	239	10	0 to	240	0	0	236	10	0 to	237	0	0
39	10	0 to	40	0	0	240	0	0 to	240	10	0	238	0	0 to	238	10	0
39	15	0 to	40	0	0	241	0	0 to	241	10	0	238	15	0 to	239	0	0
39	15	0 to	40	0	0	243	10	0 to	244	0	0	241	0	0 to	241	5	0
40	0	0 to	40	10	0	248	0	0 to	248	10	0	245	5	0 to	245	10	0
40	2	6 to	40	12	6	247	0	0 to	247	10	0	244	10	0 to	244	15	0
41	12	6 to	42	5	0	249	10	0 to	250	0	0	247	10	0 to	247	15	0
41	15	0 to	42	0	0	250	0	0 to	250	10	0	248	10	0 to	249	0	0

plate trade being rather quiet.

The average price of cash standard tin in June 1919, was £238. 8s. 2d.; May 1919, £234. 9s. 5d.; June 1918, £331. 10s.; and May 1918, £364. 7s. 8d.

LEAD.—Values of this metal have shown little material change during the month of June. At the end of May the official prices were £22. 15s. to £23. About the middle of the month prices had improved to £23. 2s. 6d. to £23. 7s. 6d., while at the end of June the close is £22. 7s. 6d. to £22. 10s. The Government stocks of the metal in this country, exclusive of old metal and scrap, on June 1 amounted to 119,907 tons, compared with 109,012 tons on May 1, so that the stock had increased on the month by 10,895 tons. The fact that the stocks are so large, and have shown an increase, coupled with the fact that large stocks of Mexican lead are understood to exist in the United States, while good quantities of the metal are also available in Australia, has had rather a subduing effect on the market in general. The consuming trades in this country do not appear to have made such good progress as was expected at one time, but at the present level of values, lead appears to be considered a fairly cheap purchase, and rather more interest has been shown in the metal on 'Change. The outlook is obscure, owing to the prevalence of such large stocks, but, as prices seem to be below cost of production, this may have a stabilizing effect on the market.

Average prices of soft pig lead: June 1919, £22. 12s. 2d.; May 1919, £23. 18s. 6d.; June 1918, £29; May 1918, £29.

SPELTER.—This market has shown a good tone during June, values having steadily improved until at the close they showed a rise of about £3 compared with the end of May. The strength has been largely derived from America, where prices have advanced from slightly over 6c. to about 7c. per pound during the same period. The generally satisfactory tone of the market has stimulated a considerable demand from consumers, and it is understood that the Government recently has been able to dispose of fair quantities of the metal. Refined spelter (99·9%) has not, however, improved to the same extent as virgin, owing to the fact that the demand for brass-making purposes has not been so important as that for galvanizing. Other grades of the metal have been well held, hard spelter fetching up to about £28. 10d., while Indian brands of hard have realized £36. 10s. Rather more inquiry for spelter has been seen from the galvanized sheet trade, which is a satisfactory feature, as this particular trade has not been an important buyer for a long time.

Average prices of spelter: June 1919, £36. 19s. 6d.; May 1919, £35. 13s. 9d.; June 1918, £52; and May 1918, £52.

ZINC DUST.—High-grade Australian zinc dust 88—92% purity is steady at £70 per ton f.o.r.

ANTIMONY.—There is no change in English regulus, which is still quoted at £45 per ton. Rather more interest has been seen in foreign regulus on spot, and £44 has been paid for Chinese. French antimony has also been offering here, and the embargo has now been lifted upon imports, so that it may not be long before arrivals come in.

ARSENIC.—The market is still quiet, but firm. The price of white delivered London is about £35 per ton.

BISMUTH.—12s. 6d. per lb. nominal.

CADMIUM.—6s. 9d. to 7s. per lb.

ALUMINIUM.—£150 per ton for the home trade.

NICKEL.—£195 per ton for the home trade, and £210 per ton for export.

COBALT METAL.—12s. 6d. to 13s. per lb.

COBALT OXIDE.—7s. 9d. per lb.

PLATINUM.—450s. nominal per oz.

PALLADIUM.—500s. nominal per oz.

QUICKSILVER.—The market is firm at about £18 .10s. to £19 per flask.

SELENIUM.—12s. to 15s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER.—£48 per ton f.o.b. for export, and £45 for the home trade.

MANGANESE ORE.—The market is dull, and Indian grades are quoted nominally about 2s. 3d. c.i.f. per unit

TUNGSTEN ORES.—Wolframite 65%, 30s. per unit, and scheelite 30s. per unit.

MOLYBDENITE.—85% 75s. per unit.

SILVER has fluctuated during the month, having touched 54⅞d. for spot standard, but on balance the market on the month is unchanged, the quotation being 53d. at the end of June. The price of fine in New York touched 112½c, but closed the month at 108¼c.

CORUNDUM.—90%, nominal.

GRAPHITE.—80% c.i.f. U.K., £40 to £45 per ton.

IRON AND STEEL.—The ore market has been firm owing to the increase in freights, and it is believed that values of hematite will have to advance further in consequence. Meanwhile considerable stringency has been experienced in the hematite iron trade, there being little prompt iron obtainable, while there is little disposition to sell forward. A good demand was felt for Cleveland pig iron, but latterly business has been quieter owing to the approach of the holiday season. Home prices stand at 164s. for No. 1 and 160s. for No. 3 Cleveland G.M.B. and No. 4 foundry, with No. 4 forge at 157s. to 158s. In the manufactured iron and steel trade, a strike of engineers on the Tees-side somewhat hampered operations, but an early settlement is anticipated. Meanwhile ship-plates are in good demand, but the inquiry for sectional material is comparatively quiet. There is a good deal of American material on offer, and as the tendency in freights seems to be downwards, this may increase competition from that source. An interesting item in this connection is that the tender of the United States Steel Products Co. for 5,000 tons of tram rails for Glasgow has been accepted at a price of £17. 9s. c.i.f., against the best British quotation of £19. 1s. 3d. It is reported, however, that America is talking prices up, but at the same time works there seem to be in need of orders.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz	£
January, 1918	694,121	19,991	714,112	3,033,653
February	637,571	22,188	659,759	2,802,477
March	677,008	19,273	696,281	2,957,614
April	697,733	19,366	717,099	3,046,045
May	720,539	20,778	741,317	3,148,915
June	708,908	18,788	727,696	3,091,058
July	716,010	20,189	736,199	3,127,174
August	719,849	20,361	740,210	3,144,211
September	686,963	21,243	708,206	3,008,267
October	667,955	11,809	679,764	2,887,455
November	640,797	17,904	658,701	2,797,983
December	630,505	10,740	641,245	2,723,836
Year 1918	8,197,9[illegible]	221,734	8,419,693	35,76[illegible]
January, 1919	[illegible]	13,854	676,0[illegible]	[illegible]
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	[illegible]	[illegible]	[illegible]

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
April 30, 1918	182,492	11,322	4,753	198,567
May 31	179,879	11,211	4,773	195,863
June 30	179,028	11,473	4,747	[illegible]
July 31	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	[illegible]
September 30	[illegible]	12,108	[illegible]	196,395
October 31	[illegible]	[illegible]	4,749	[illegible]
November 30	160,275	11,826	4,016	[illegible]
December 31	[illegible]	11,851	[illegible]	167,637
January 31, 1919	[illegible]	[illegible]	[illegible]	[illegible]
February 28	172,359	11,868	[illegible]	[illegible]
March 31	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	[illegible]	5,939	191,547

Cost and Profit on the Rand

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton		Work'g cost per ton		Work'g profit per ton		Total working profit
		s	d	s.	d	s.	d.	£
January, 1918	2,167,411	27	1	20	7	6	4	703,665
February	1,946,338	27	8	21	7	5	11	577,396
March	2,107,561	27	1	21	4	5	8	596,109
April	2,181,609	27	0	20	8	6	2	670,871
May	2,237,644	27	3	20	6	6	5	716,963
June	2,134,205	28	2	21	0	6	11	[illegible]
July	2,167,869	27	10	21	2	6	6	[illegible]
August	2,158,431	28	1	21	7	6	[illegible]	676,146
September	2,060,635	28	2	22	0	5	10	600,330
October	2,015,144	28	0	22	5	5	3	531,774
November	1,899,925	28	5	23	1	5	1	[illegible]
December	1,855,991	28	7	[illegible]	0	5	6	507,860
Year 1918	[illegible]	27	11	21	7	6	0	[illegible]
January, 1919	1,942,329	28	9	23	0	5	8	547,793
February	1,816,352	28	9	23	[illegible]	5	6	[illegible]
March	2,082,469	28	2	22	6	5	6	573,582
April	1,993,652	28	7	22	9	5	9	573,143

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1918	1919	1918	1919
	£	£	£	£
January	253,807	211,917	107,863	[illegible]
February	232,023	220,885	112,865	112,616
March	230,023	225,808	112,605	[illegible]
April	239,916	213,160	117,520	[illegible]
May	239,205	218,057	126,290	[illegible]
June	225,447	—	120,273	—
July	251,740	—	117,581	—
August	257,096	—	120,526	—
September	247,885	—	115,152	—
October	136,780	—	61,461	—
November	[illegible]	—	108,796	—
December	192,870	—	112,621	—
Total	2,652,250	1,089,827	1,333,553	539,619

Transvaal Gold Outputs

	May, 1919	
	Treated	Value
	Tons	£
Aurora West	14,800	16,511
Bantjes	—	—
Barrett	—	635
Brakpan	48,800	91,024
City & Suburban	18,270	[illegible]
City Deep	50,000	98,556
Cons. Langlaagte	45,800	56,606
Cons. Main Reef	50,230	[illegible]
Crown Mines	164,000	[illegible]
Durban Roodepoort Deep	24,100	35,300
East Rand P.M.	[illegible]	141,800
Ferreira Deep	33,600	53,983
Geduld	43,000	65,198
Geldenhuis Deep	49,500	[illegible]
Ginsberg	10,400	[illegible]
Glynn's Lydenburg	3,885	7,078
Goch	16,700	[illegible]
Government G.M. Areas	125,000	[illegible]
Heriot	12,180	[illegible]
Jupiter	23,600	[illegible]
Kleinfontein	59,480	[illegible]
Knights Central	22,500	[illegible]
Knights Deep	93,100	73,415
Langlaagte Estate	42,200	[illegible]
Luipaard's Vlei	20,850	—
Meyer & Charlton	14,450	[illegible]
Modderfontein	[illegible]	177,709
Modderfontein B	55,000	[illegible]
Modderfontein Deep	44,200	[illegible]
New Unified	[illegible]	[illegible]
Nourse	[illegible]	55,431
Primrose	20,300	[illegible]
Princess Estate	20,500	27,655
Randfontein Central	144,000	166,162
Robinson	40,900	43,215
Robinson Deep	52,200	72,354
Roodepoort United	[illegible]	21,557
Rose Deep	51,500	[illegible]
Simmer & Jack	54,800	[illegible]
Simmer Deep	43,700	41,956
Springs	36,070	[illegible]
Sub Nigel	10,300	25,025
Transvaal G.M. Estates	16,830	24,596
Van Ryn	35,900	34,231
Van Ryn Deep	[illegible]	103,492
Village Deep	47,200	67,572
Village Main Reef	19,400	[illegible]
West Rand Consolidated	33,120	[illegible]
Witwatersrand (Knights)	35,500	[illegible]
Witwatersrand Deep	31,600	[illegible]
Wolhuter	30,000	[illegible]

West African Gold Outputs

	May, 1919	
	Treated	Value
	Tons	£
Abbontiakoon	8,040	15,546
Abosso	7,390	[illegible]
Ashanti Goldfields	[illegible]	32,406
Prestea Block A	15,140	[illegible]
Taquah	5,120	14,184
Wassau	2,037	2,893

Rhodesian Gold Outputs

	May, 1919	
	Treated	Value
	Tons	£
Antelope	3,215	4,341
Cam & Motor	—	—
Eldorado Banket	3,396	5,770
Falcon	[illegible]	[illegible]*
Gaika	[illegible]	5,481
Globe & Phoenix	6,034	8,508†
Lonely Reef	4,680	24,403
Rezende	5,500	[illegible]‡
Rhodesia, Ltd	590	1,113
Shamva	56,061	34,024
Transvaal & Rhodesian	1,700	5,400
Wanderer	—	—

* Gold, Silver and Copper; † Ounces Gold; ‡ Gold & Silver.

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January, 1918	*	73,703	*	*
February	*	76,987	*	*
March	*	69 730	*	*
April	*	66,079	*	*
May	*	73,701	*	*
June	*	74,904	*	*
July	*	72,081	*	*
August	*	76,156	*	*
September	*	74,057	*	*
October	*	71,439	*	*
November	1,444	70,711	72,155	306,494
December	2,739	61,314	64,053	272,208
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	*nil*	66,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856

* By direction of the Federal Government the export figures from July, 1916, to November, 1918, were not published.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1918	1919	1918	1919	1918	1919
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	25,000	18,000
February	58,113	46,955	45,470	43,330	28,000	24,000
March	65,412	40,267	48,020	48,000	30,000	16,000
April	26,849	—	47,600	61,200	30,000	24,000
May	87,8[illegible]5	—	46,740	38,200	45,000	16,000
June	45,765	—	51,420	—	32,000	—
July	64,347	—	51,000	—	25,000	—
August	61,163	—	44,600	—	21,000	—
September	65,751	—	45,900	—	32,000	—
October	*	—	54,400		40,000	—
November	*	—	38,200	—	25,000	—
December	70,674	—	56,281	—	38,000	—
Total	674,655	123,461	578,213	227,830	370,000	98,000

* Figures not received.

Australasian Gold Outputs.

	May, 1919	
	Treated	Value
	Tons	£
Associated	6,161	8,673
Associated Northern Blocks — Iron Duke	—	1,820*
Associated Northern Blocks — Victorious	2,034	3,180
Blackwater	2,208	3,326
Bullfinch	5,006	5,146
Golden Horseshoe	12,636	23,587
Great Boulder Prop.	13,622	39,534
Ivanhoe	18,243	31,570
Kalgurli	2,703	5,929
Lake View & Star	9,623	11,604
Mount Boppy	—	—
Oroya Links	1,507	10,816†
Progress	1,680	1,689
Sons of Gwalia	12,758	17,460
South Kalgurli	8,498	11,006
Talisman	—	—
Waihi	15,119	25,159‡
Waihi Grand Junction	5,670	8,246§

* Surplus; † Total receipts; ‡ Gold and Silver to May 17.
§ 23 days to May 17.

Miscellaneous Gold Output.

	May, 1919	
	Treated	Value
	Tons	£
Barramia (Sudan)	—	—
Esperanza (Mexico)	13,506	3,668††
Frontino & Bolivia (Colombia)	2,500	8,989
Nechi (Colombia)	—	—
Ouro Preto (Brazil)	7,200	10,087
Pato (Colombia)	—	—
Philippine Dredges (Philippine Islands)	—	770§
Plymouth Cons. (California)	10,500	12,960
St. John del Rey (Brazil)	—	40,000
Santa Gertrudis (Mexico)	33,950	26,150††
Sudan Gold Field (Sudan)	1,530	3,200

§ Ounces, fineness not stated; †† Profit, gold and silver.

Production of Gold in India.

	1916	1917	1918	1919
	£	£	£	£
January	192,150	190,047	176,030	162,270
February	183,264	180,904	173,343	153,775
March	186,475	189,618	177,950	162,7[illegible]
April	192,208	185,835	176,486	162,550
May	193,604	184,874	173,775	164,080
June	192,469	182,426	174,375	—
July	191,404	179,660	171,950	—
August	192,784	181,005	172,105	—
September	192,330	183,630	170,360	—
October	191,502	182,924	167,740	—
November	192,298	182,388	157,176	—
December	205,164	190,852	170,630	—
Total	2,305,652	2,214,163	2,061,920	807,465

Indian Gold Outputs.

	May, 1919	
	Tons Treated	Fine Ounces
Balaghat	2,550	2,194
Champion Reef	11,853	7,[illegible]
Hutti (Nizam's)	—	9[illegible]
Jibutil	—	—
Mysore	24,578	13,712
North Anantapur	1,000	913
Nundydroog	9,004	6,450
Ooregum	12,900	7,359

Base Metal Outputs.

		May, 1919
Arizona Copper	Short tons copper	1,200
British Broken Hill	Tons lead concentrate	807*
	Tons zinc concentrate	600*
	Tons carbonate ore	130*
Broken Hill Block 10	Tons lead concentrate	1,113
	Tons zinc concentrate	917
Burma Corp.	Tons refined lead	1,587
	Oz. refined silver	[illegible]
Cordoba Copper		—
Freemantle Trading	Long tons lead	—
North Broken Hill	Tons lead	650*
	Oz. silver	26,373†
Poderosa	Tons copper ore	208
Rhodesian Broken Hill	Tons lead and zinc	1,221
Tanganyika	Long tons copper	[illegible]55
Tolima	Tons silver-lead concentrate	50
Zinc Corp.	Tons zinc concentrate	—
	Tons lead concentrate	—

* One week; † Two weeks.

Imports of Ores and Metals into United Kingdom.
Long tons.

	June 1919	Year 1919
	Tons	Tons
Iron Ore	[illegible]	2,555,[illegible]
Copper Ore	417	[illegible]
,, Precipitate	140	5,[illegible]
,, Metal	5,002	68,[illegible]
Copper and Iron Pyrite	14,064	136,005
Tin Concentrate	[illegible]	[illegible]
,, Metal	[illegible]	[illegible]
Manganese Ore	[illegible]	194,601
Lead, Pig and Sheet	[illegible]	15[illegible],258
Zinc (spelter)	[illegible]	54,905
Zinc Oxide	[illegible]	1,231
Barytes	[illegible]	10,070
Rock Phosphate	[illegible]	10,256
Brimstone	57	5,160
Boracic Compounds	795	5,78[illegible]
Nitrate of Potash	1,327	5,347
	lb.	lb.
Quicksilver	375,000	1,313,100

United States Metal Exports and Imports.

Exports.	Mar. Tons.	April Tons.	Imports.	Mar Tons.	April Tons.
Copper Ingots	5,843	7,965	Antimony......	591	433
Copper Sheets	381	580	Tin Ore.........	1,066	[illegible]
Copper Wire..	5,375	[illegible]	Tin	[illegible]	225
Lead, Pig......	3,091	2,375	Manganese Ore	48,238	[illegible]
Zinc	7,214	16,075	Tungsten Concentrate	675	314
Zinc Sheets ..	2,396	962	Pyrites	12,959	25,294

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Year 1918 Tons	May 1919 Tons	Year 1919 Tons
Nigeria:			
Abu	33	2	10
Anglo-Continental	207	–	[illegible]
Benue	146	7	42
Berrida	–	[illegible]	1
Bisichi	275	[illegible]	[illegible]
Bongwelli	17	1	20
Dua	60	4	34
Ex-Lands	[illegible]	–	118
Filani	37	1	[illegible]
Forum River	274	11	72
Gold Coast Consolidated	30	[illegible]	[illegible]
Gurum River	[illegible]	–	45
Jantar	141	9	49
Jos	228	[illegible]	[illegible]
Kaduna	[illegible]	[illegible]	103
Kano	60	[illegible]	[illegible]
Kassa-Ropp	[illegible]	[illegible]	[illegible]
Keffi	118	4	30
Kuru	[illegible]	30	[illegible]
Kuskie	1		3
Kwall	[illegible]	–	[illegible]
Lower Bisichi	[illegible]	7	44
Lucky Chance	27	[illegible]	14
Minna	40	3	14
Mongu	476	[illegible]	245
Naraguta	[illegible]	[illegible]	161
Naraguta Extended	280	15	[illegible]
New Lafon	[illegible]	21	104
Nigerian Tin	87	–	25
Ninghi	—	6	16
N. N. Bauchi	435	[illegible]	143
Ofin River	120	–	15
Rayfield	[illegible]	50	[illegible]
Ropp	[illegible]	[illegible]	419
Rukuba	132	–	17
South Bukeru	94	4	23
Sybu	40	[illegible]	14
Tin Areas	96	[illegible]	34
Tin Fields	108	[illegible]	[illegible]
Toro	17	–	3
Federated Malay States:			
Chenderiang	179	–	[illegible]
Gopeng	[illegible]	[illegible]	376
Idris Hydraulic	136	16	93
Ipoh	[illegible]	[illegible]	61
Kamunting	[illegible]	–	[illegible]
Kinta	[illegible]	[illegible]	179
Kledang	[illegible]	–	[illegible]
Lahat	[illegible]	41	154
Malayan Tin	730	59	291
Pahang	1,877	199	[illegible]
Rambutan	207	12	[illegible]
Sungei Besi	[illegible]	[illegible]	114
Tekka	508	36	197
Tekka-Taiping	[illegible]	20	130
Tronoh	1,364	115	604
Tronoh South	133		–
Cornwall:			
Cornwall Tailings	140	–	–
Dolcoath	787	57	292
East Pool	1,336	80	495
Geevor	[illegible]	34	186
South Crofty	598	41	222
Other Countries:			
Aramayo Francke (Bolivia)	1,816	228	851
Briseis (Tasmania)	327	18	104
Deebook (Siam)	398	26	137
Mawchi (Burma)	658	85	295
Porco (Bolivia)	227	21	114
Renong (Siam)	615	124	394
Rooiberg Minerals (Transvaal)	335	[illegible]	164
Siamese Tin (Siam)	989	77	[illegible]
Tongkah Harbour (Siam)	1,528	105	461
Zaaiplaats (Transvaal)	563	40	255

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	485	417	531	667	678	613
February ...	469	358	528	646	668	623
March	502	418	547	655	707	587
April	482	444	486	555	584	531
May	480	357	536	[illegible]	525	436
June	460	373	510	473	492	—
July	432	455	506	479	545	—
August	228	438	498	551	571	—
September	[illegible]	442	535	538	520	—
October	272	511	584	578	[illegible]	—
November ...	283	467	679	[illegible]	[illegible]	—
December ...	326	[illegible]	654	655	518	—
Total	4,708	5,213	6,594	6,927	[illegible]	[illegible]

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
July 1	[illegible]	[illegible]	£[illegible] 12 5
July 15	[illegible]	[illegible]	£[illegible] 19 0
July 29	[illegible]	[illegible]	£[illegible] 4 6
August 12	[illegible]	£[illegible]	£[illegible] 19 6
August 26	142	£31,211	£[illegible] 16 0
September 9	142½	[illegible]	£[illegible] 1 2
September 23	[illegible]	[illegible]	£203 7 2
October 7	[illegible]	[illegible]	£[illegible] 14 3
October 21	[illegible]	[illegible]	£197 16 4
November 4	141¼	[illegible]	£195 13 1
November 18	150	[illegible]	£[illegible] 19 9
December 2	166¾	[illegible]	£[illegible] 19 0
December 16	175½	[illegible]	£148 6 7
December 30	[illegible]	[illegible]	£[illegible] 11 1
Total and Average 1918	4,094	£[illegible]	£[illegible] 0 0
January 13 1919	160	[illegible]	£1[illegible]0 11 0
January 27	135½	£17,[illegible]	£[illegible] 10 7
February 10	[illegible]	£17,[illegible]	£[illegible] 10
February 24	142	£[illegible]15	£[illegible] 14 10
March 10	144½	[illegible]	£[illegible] 8 5
March 24	[illegible]	£17,[illegible]	£[illegible] 7 8
April 7	[illegible]	£15,[illegible]	£111 8 10
April 22	134¼	£15,[illegible]	£111 18 1
May 5	[illegible]	[illegible]	£115 13 2
May 19	126½	£15,844	£125 5 0
June 2	140	£17,185	£122 15 0
June 16	139	£17,[illegible]	£123 15 9
June 30	[illegible]	[illegible]	£123 8 0

Details of Redruth Tin Ticketings.

	June 2 Tons Sold	June 2 Realized per ton £ s d	June 16 Tons Sold	June 30 Tons Sold
E. Pool & Agar, No. 1	10	118 15 0	10	10
" " No. 1a	10	118 5 0	10	10
" " No. 1b	10	118 15 0	10	10
" " No. 1c	10	118 15 0	10	10
Dolcoath, No. 1	9	127 10 0	7	[illegible]
" No. 1a	9	128 15 0	8	[illegible]
" No. 1b	10	129 5 0	[illegible]	9
" No. 2	[illegible]	[illegible] 15 0	4	4
" A	1	112 15 0	[illegible]	—
South Crofty, No. 1	[illegible]	126 0 0	9	11
" " No. 1a	11	126 15 0	10	11
Grenville Utd., No. 1	[illegible]	119 0 0	7	[illegible]
" " No. 1a	[illegible]	[illegible] 0 0	7	7
" " No. 2	—	—	3	—
Tincroft Mines, No. 1	6	126 15 0	6	6
" " No. 1a	6	127 [illegible] 6	6	6
Levant Mines, No. 1	10	129 15 0	[illegible]	8
" No. 1a	9	129 15 0	[illegible]	7
Wheal Bellan	—	—	[illegible]	—
Hingston Downs	—	—	[illegible]	—
Trencrom Hill	—	—	—	1
Total	140		139	136

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons. *Figures not published.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January ...	4,395	4,316	3,558	3,149	3,765
February ...	3,780	3,372	2,755	3,191	2,673
March	3,653	3,696	3,286	2,608	2,819
April	3,619	3,177	3,251	3,308	2,855
May	3,823	3,729	3,413	3,332	3,404
June	4,048	3,435	3,489	2,950	2,873
July	3,544	3,517	3,253	3,373	—
August	4,046	3,732	3,413	3,259	—
September .	3,932	3,636	3,154	3,166	—
October......	3,797	3,681	3,436	2,870	—
November .	4,059	3,635	3,300	3,131	—
December .	4,071	3,945	3,525	3,023	—
	46,767	43,871	39,833	37,370	18,389

STOCKS OF TIN

Reported by A. Strauss & Co. Long Tons.

	May 31 1919	June 30, 1919
	Tons	Tons
Straits and Australian Spot	1,199	1,816
Ditto, Landing and in Transit	797	971
Other Standard, Spot and Landing ...	613	793
Straits, Afloat.......................................	2,044	1,824
Australian, Afloat..................................	336	332
Banca, on Warrants..............................	—	—
Ditto, Afloat	105	—
Billiton, Spot	—	—
Billiton, Afloat	—	—
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	75	265
Total Afloat for United States............	10	25
Stock in America	100	182
Total	5,279	6,208

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.

Reported by A. Strauss & Co. Long tons.

	May 1919	June 1919
	Tons	Tons
Shipments from:		
Straits to U.K.	1,639	1,349
Straits to America	10	25
Straits to Continent........................	55	265
Straits to Other Places	—	1,107
Australia to U.K.	150	150
U.K. to America	—	—
Imports of Bolivian Tin into Europe...	1,637	1,540
Supply:		
Straits	1,704	1,639
Australian	150	150
Billiton	50	—
Banca	171	—
Standard	254	658
Consumption:		
U.K. Deliveries................................	1,937	1,375
Dutch ,, ...	112	52
American ,, ...	20	68
Straits, Banca & Billiton, Continental Ports, etc.	172	244
Straits in hands of Malay Government	6,000 to 7,000	—
,, controlled by U.S. Government	--	—
,, ,, ,, French and Italian Governments......	—	--
Banca and Billiton controlled by Dutch Government	3,000 to 4,000	

PRICES OF CHEMICALS. July 8

		£	s.	d.
Alum	per ton	17	0	0
Alumina, Sulphate of	,,	19	0	0
Ammonia, Anhydrous...............	per lb.		1	10
,, 0·880 solution	per ton	33	0	0
,, Carbonate	per lb.			6½
,, Chloride of, grey......	per ton	50	0	0
,, ,, ,, pure......	per cwt.	4	0	0
,, Nitrate of	per ton	58	0	0
,, Phosphate of............	,,	114	0	0
,, Sulphate of	,,	17	10	0
Antimony Sulphide	per lb.		1	3
Arsenic, White........................	per ton	35	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	54	0	0
Bleaching Powder, 35% Cl.	,,	15	0	0
Borax	,,	39	0	0
Copper, Sulphate of	,,	45	0	0
Cyanide of Sodium, 100%.........	per lb			10
Hydrofluoric Acid	,,			7
Iodine..	,,		14	0
Iron, Sulphate of.....................	per ton	5	0	0
Lead, Acetate of, white	,,	85	0	0
,, Nitrate of	,,	59	0	0
,, Oxide of, Litharge	,,	45	0	0
,, White	,,	52	0	0
Lime, Acetate, brown............. .	,,	10	0	0
,, ,, grey 80%............	,,	17	0	0
Magnesite, Calcined	,,	25	0	0
Magnesium Chloride	,,	16	0	0
,, Sulphate...............	,,	11	0	0
Methylated Spirit 64° Industrial	per gal.		6	7
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	,,		1	6
,, Carbonate	per ton	85	0	0
,, Chlorate	per lb.		1	2
,, Chloride 80%	per ton	30	0	0
,, Hydrate, (Caustic) 90%	,,	150	0	0
,, Nitrate.....................	,,	60	0	0
,, Permanganate	per lb.		3	6
,, Prussiate, Yellow	,,		1	9
,, Sulphate, 90%	per ton	40	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	53	0	0
,, Arsenate 45%..............	,,	48	0	0
,, Bicarbonate	,,	9	10	0
,, Bichromate	per lb.			11
,, Carbonate (Soda Ash)...	per ton	10	0	0
,, ,, (Crystals) ...	,,	4	5	0
,, Chlorate.....................	per lb.			8
,, Hydrate, 76%	per ton	23	10	0
,, Hyposulphite	,,	16	0	0
,, Nitrate, 95%...............	,,	21	0	0
,, Phosphate	,,	25	10	0
,, Prussiate.....................	per lb.			7½
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)......	,,	3	0	0
,, ,, (Glauber's Salts)	,,	3	0	0
,, Sulphide.....................	,,	22	0	0
Sulphur, Roll..........................	,,	20	0	0
,, Flowers.....................	,,	21	0	0
Sulphuric Acid, Non-Arsenical...				
140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%...	,,	5	0	0
Tartaric Acid..........................	per lb.		3	2
Zinc Chloride	per ton	25	0	0
Zinc Sulphate	,,	22	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	July 5 1918 £	s.	d.	July 7 1919 £	s.	d.
RAND						
Bantjes		2	9		3	
Brakpan	4	7	6	3	10	
Central Mining (£8)	6	3	9	9	0	0
Cinderella		4	0		5	3
City & Suburban (£4)		17	0		13	9
City Deep	3	0	0	2	16	3
Consolidated Gold Fields	1	14	6	1	18	9
Consolidated Langlaagte		17	0	1	0	6
Consolidated Main Reef		14	6		14	6
Consolidated Mines Selection (10s).	1	5	9	1	4	0
Crown Mines (10s.)	2	0	6	2	1	3
Daggafontein	1	5	6	1	5	0
Durban Roodepoort Deep		10	3		9	0
East Rand Proprietary		3	9		5	9
Ferreira Deep*		12	6		11	3
Geduld	1	18	0	1	8	9
Geldenhuis Deep		12	6		11	3
Gov't Gold Mining Areas	1	13	9	1	17	6
Heriot	1	0	0		15	0
Jupiter		4	0		5	0
Kleinfontein		14	0		1[illegible]	6
Knight Central		3	0		6	[illegible]
Knight's Deep		7	6		8	[illegible]
Langlaagte Estate		14	0	1	0	6
Meyer & Charlton	4	17	6	4	18	9
Modderfontein (£4)	24	0	0	26	10	0
Modderfontein B	7	1[illegible]	6	8	10	0
Modder Deep	7	12	6	7	10	0
Nourse		16	3		16	3
Rand Mines (5s.)	2	13	9	2	17	6
Rand Selection Corporation	4	12	6	3	11	3
Randfontein Central		10	6		11	6
Robinson (£5)		15	6		14	0
Robinson Deep A (1s.)	1	[illegible]	6		18	[illegible]
Rose Deep		19	6		17	6
Simmer & Jack		5	0		5	0
Simmer Deep		[illegible]	9		[illegible]	[illegible]
Springs	3	16	3	2	16	3
Sub Nigel	1	8	9	1	5	0
Van Ryn		19	6		18	0
Van Ryn Deep	3	12	0	3	1[illegible]	6
Village Deep		18	0		16	3
Village Main Reef		14	6		1[illegible]	6
Witwatersrand (Knight's)	1	5	0	1	5	0
Witwatersrand Deep		7	3		12	6
Wolhuter		4	0		4	0
OTHER TRANSVAAL GOLD MINES						
Glynn's Lydenburg		19	6	1	1	3
Sheba (5s.)			9		1	3
Transvaal Gold Mining Estates		15	6		15	0
DIAMONDS IN SOUTH AFRICA						
De Beers Deferred (£2 10s.)	14	10	0	23	7	6
Jagersfontein	4	2	6	6	5	0
Premier Deferred (2s. 6d.)	6	12	6	8	0	0
RHODESIA:						
Cam & Motor		11	6		6	0
Chartered British South Africa		15	6	1	3	0
Eldorado		7	9		5	6
Falcon	1	2	0		13	0
Gaika		14	0		17	6
Giant		7	6		7	6
Globe & Phœnix (5s.)	1	9	6	1	7	0
Lonely Reef	1	16	3	2	13	9
Rezende	4	2	6	5	2	6
Shamva	1	18	9	1	18	9
Wanderer (3s.)		1	0		1	0
Willoughby's (10s.)		5	0		6	6
WEST AFRICA:						
Abbontiakoon (10s.)		3	9		5	3
Abosso		7	6		10	0
Ashanti (4s.)		19	6	1	2	9
Prestea Block A		3	9		5	9
Taquah		15	0		17	3
WEST AUSTRALIA:						
Associated Gold Mines		3	0		4	0
Associated Northern Blocks		3	0		3	9
Bullfinch		1	9		1	6
Golden Horse-Shoe (£5)	2	1	3	1	13	9
Great Boulder Proprietary (2s.)		10	0		9	9
Great Fingall (10s.)		1	9		1	[illegible]
Ivanhoe (£5)	1	17	0	1	18	9
Kalgurli		9	0		11	6
Sons of Gwalia		8	3		6	6

GOLD, SILVER, *cont.*	July 5 1918 £	s.	d.	July 7 1919 £	s	d
OTHERS IN AUSTRALASIA:						
Mount Boppy, New South Wales		6	0		1	6
Talisman, New Zealand		15	0		8	9
Waihi, New Zealand	1	17	6	2	5	0
Waihi Grand Junction, New Z'lnd		15	0		12	6
AMERICA:						
Alaska Treadwell (£5), Alaska		12	6	1	12	6
Buena Tierra, Mexico		12	6		18	9
Camp Bird, Colorado		13	9	1	4	3
Casey Cobalt, Ontario		6	0		2	9
El Oro, Mexico		10	3	1	2	6
Esperanza, Mexico		8	0		15	9
Frontino & Bolivia, Colombia		12	6		10	0
Le Roi No. 2 (£5), British Columbia		6	0		11	3
Mexico Mines of El Oro, Mexico	5	12	6	7	5	0
Oroville Dredging, California		18	3	1	8	0
Plymouth Consolidated, California	1	2	6	1	8	3
St. John del Rey, Brazil		17	6		19	0
Santa Gertrudis, Mexico		14	3	1	8	9
Tomboy, Colorado		13	9		15	6
RUSSIA:						
Lena Goldfields	1	7	6	1	12	6
Orsk Priority		1	0		16	3
INDIA:						
Balaghat		4	3		9	[illegible]
Champion Reef (2s. 6d.)		5	3		4	[illegible]
Mysore (10s.)	2	13	9	2	3	9
North Anantapur		3	9		3	6
Nundydroog (10s.)	1	2	9		18	0
Ooregum (10s.)		18	3		16	[illegible]

COPPER

Arizona Copper (5s.), Arizona	2	8	9	2	1	3
Cape Copper (£2), Cape Province	2	10	0	2	9	3
Chillagoe (10s.), Queensland		1	0		1	9
Cordoba (5s.), Spain		2	0		1	3
Great Cobar (£5), N.S.W.		2	0		1	6
Hampden Cloncurry, Queensland	1	6	0		19	6
Kyshtim, Russia	1	4	6	1	15	9
Messina (5s.), Transvaal		8	6		5	0
Mount Elliott (£5), Queensland	3	8	0	3	0	0
Mount Lyell, Tasmania	1	8	9	1	3	9
Mount Morgan, Queensland	1	11	9	1	3	9
Namaqua (£2), Cape Province	1	12	6	2	0	0
Rio Tinto (£5), Spain	67	10	6	59	10	0
Sissert, Russia				1	5	6
Spassky, Russia	1	2	0	1	15	0
Tanalyk, Russia	1	2	6	1	18	9
Tanganyika, Congo and Rhodesia	3	14	6	4	18	9
Tharsis (£2), Spain	6	10	0	5	2	6

LEAD-ZINC

BROKEN HILL:						
Amalgamated Zinc	1	6	0	1	5	9
British Broken Hill	2	10	9	1	19	6
Broken Hill Proprietary (8s.)	3	4	6	2	3	9
Broken Hill Block 10 (£10)	1	17	6	1	3	9
Broken Hill North	3	5	0	2	7	6
Broken Hill South	12	0	0	2	5	9*
Sulphide Corporation (15s.)	1	9	6	1	1	3
Zinc Corporation (10s.)	1	8	6	1	[illegible]	9
ASIA:						
Burma Corporation	4	7	6	7	13	9
Irtysh Corporation	1	2	0	1	18	9
Russian Mining		11	3	1	0	0
Russo-Asiatic	2	10	0	4	12	6

TIN

Aramayo Francke, Bolivia	2	6	3	4	0	0
Bisichi, Nigeria		14	6		14	0
Briseis, Tasmania		6	0		5	0
Dolcoath, Cornwall		10	3		11	9
East Pool, Cornwall	1	9	0		17	6
Ex-Lands Nigeria (2s.), Nigeria		3	0		3	0
Geevor (10s.) Cornwall	1	[illegible]	0	1	0	[illegible]
Gopeng, Malay	1	18	0	2	[illegible]	[illegible]
Ipoh Dredging, Malay		18	6	1	2	[illegible]
Malayan Tin Dredging, Malay	2	1	3	2	8	[illegible]
Mongu (10s.), Nigeria		14	6		19	[illegible]
Naraguta, Nigeria		17	6		17	[illegible]
N. N. Bauchi Pref. (10s.), Nigeria		12	9		12	[illegible]
„ Ord. (10s.),		7	6		7	[illegible]
Pahang Consolidated (5s.), Malay		12	6		16	[illegible]
Rayfield, Nigeria		14			16	
Reneng Dredging, Siam	2	6	3	2	5	[illegible]
Ropp (4s.), Nigeria	1	2	6	1	1	[illegible]
Siamese Tin, Siam	3	6	3	3	2	[illegible]
South Crofty (5s.), Cornwall	2	12	6	1	13	9
Tekka, Malay	3	15	0	4	5	0
Tekka Taiping, Malay	3	15	0	5	7	6
Tronoh, Malay	2	[illegible]	6	2	5	0

* Share capital expanded

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

BAUXITE IN WEST AFRICA.

The report of Mr. A. E. Kitson, Director of the Gold Coast Geological Survey, for 1917, just received, contains an account of the high-grade bauxite deposits near the summit of Mt. Ejuanema. During the five months occupied in the examination, three trenches, varying from 40 to 70 ft. in length, 4 to 5 ft. in width, and 3 to 8 ft. in depth, were dug in different parts of the top of the mountain. Shafts have since been sunk, with the aid of explosives, on the mountain to prove the thickness of the deposit. The evidence so far obtained shows that the bauxite is about 20 ft. thick, and that it merges into unaltered clay-shales, which lie a few feet beneath it.

Mt. Ejuanema stands on the Kwahu plateau, two miles to the west-south-west of Mpraeso, and about a mile to the south-south-west of Obomen. It is about 2,530 ft. above sea-level, and rises about 1,000 ft above the Asuboni river on the plateau. In its upper, very steep portion it has a more or less oval shape, the longer axis being nearly east-west. In its lower portion on the northern side there are several spurs trending northward into the valley of the Asuboni river. These spurs branch from the main mountain at the foot of the very steep part consisting of sandstone cliffs, 50 ft. high in places, at from 250 to 300 ft. below the summit. They are separated from one another by little narrow deep valleys, in which are small streams, perennial along the whole or parts of their courses. These streams flow into the Asuboni river. On its south-western side the mountain presents vertical faces to the valley below. These comprise two escarpments, an upper one, varying from some 300 to 500 ft., connecting the top of the mountain with the Kwahu plateau; the lower one, from 200 to 400 ft., connecting the plateau with the valley below, and forming the Kwahu scarp, up which the four paths from the valley below rise to the towns of Mpraeso, Atibbi, Obomen, and Obo on the plateau.

The rock formations consist of a series of irregularly alternating sandstones, sandy shales, and clay-shales disposed horizontally, though in some places there are slight inclinations to north and north-east. The clay-shales are a few inches to 5 ft. thick in some places, but in others have a thickness of more than 100 ft. One of the thickest beds is on the top of Mt. Ejuanema. Another comprises the tops of the three spurs off the northern slope of the mountain. A third is at the town of Obo, some three miles to the north-west. Denudation has operated intensely on the Kwahu plateau, with the result that these deposits of sandstones and shales, of various shades of grey, green brown, yellow, chocolate, and purple colours have been deeply eroded, and in the larger valleys, such as the Asuboni with an erosion of 1,000 ft., have lost the greater part of their masses. The result of this is that on the top of Mt. Ejuanema, and at numbers of places in the valleys at different altitudes there are remnants only of the original beds of clay-shales.

Through some chemical action not definitely known at present, but probably due to the downward circulation of water, and to weathering, the original clay-shales, which consist of hyrated silicate of alumina, have been altered. They have lost nearly the whole of the silica they contained and thus the derived material is hydrated alumina. No fossils of a definite character have been found in these deposits, so their age is uncertain, but it is probable that they belong to the Devonian or to the Carboniferous period, since the beds show a strong lithological resemblance to beds occurring along the coast at Accra and near Sekondi in which fossils provisionally regarded by Dr. A. Morley Davies as of Middle Devonian and Lower Carboniferous age respectively, have been found. These sediments rest on a granitoid rock varying considerably in character from place to place. Some of it is an acid granite consisting of a flesh-pink felspar, quartz, and a little black mica; other portions have a pale green felspar, clear quartz, black mica, and hornblende. Though normally granitic in structure, it is also porphyritic with large crystals of felspar. It is an exceedingly pretty rock and would make a handsome and durable building and ornamental stone. The line of junction between the basement rock and the overlying sediments shows that the original surface of the granite was uneven when the sediments were deposited on it. At the Durabong Su the actual base of the sediments consists of pockets of a chocolate to purplish clay-shale filling hollows in the granite, while here, and at the Obomen and Obo scarps, the lowermost bed of the sediments is an arkose, a granitic gravelly sandstone or grit. Immediately overlying these are fine indurated sandstones and sandy and clay-shales in thin beds. Broadly speaking the foot of the scarp is the base of the sedimentary series.

Bauxite shows definitely *in situ* along the whole of the rim of the top of the mountain, and on the surface over a large part of the top; also apparently *in situ* at various places below the broken rim for 100 ft. in vertical distance below the top. On the northern slope of the mountain a sandstone ledge, approximately 100 ft. lower than the flat top of the mountain, shows a fairly well marked division between the clay-shale beds with bauxite overlying and the underlying sandstones. There is no doubt that the top of the mountain had originally a cap of clay-shales, in places probably 100 ft. thick. Whether that cap consisted solely of clay-shales, or had intercalated thin bands of sandstones is a point that must remain unsettled for the present. On the surface at several places on the top there are a few bits and small slabs of sandstone showing worn faces. These may be the remnants of this bed of sandstone or they may owe their presence there to human transport. The latter is probably the correct view, for there is evidence that the aborigines frequented the place, and probably made their last stand for existence behind a low curved wall of blocks of bauxite near the western end of the mountain, the remains of which are now visible.

Of the three trenches dug on the top of the mountain two are at places where the surface consists of red soil, and where, with the exception of one small piece, no massive bauxite was visible close to them. The third is in a portion where numerous blocks of bauxite outcrop at the surface. Trench No. 1 is 75 ft. long, 4 ft. broad, and 7 ft. deep. The upper portion of the 3 to 4 ft. shows red soil only. In the lower portion of 3 ft. there are big lumps and masses of bauxite, with soil containing granular bauxite between them, while the greater part of the bottom is massive bauxite of unproved thickness. The proportion of bauxite and of bauxitic soil in a given layer 3 ft. thick is estimated at 62·5% and 37·5% respectively. Trench No. 2 is 40 ft. long, 4 ft. broad, and 8 ft. deep. The upper 4 ft. consists of red soil. In the lower 4 ft. there are great blocks and big lumps of bauxite, with red soil and granular bauxite between them. In a given layer of 3 ft. in thickness the proportion of massive bauxite is 66·6% and that of granular bauxitic soil 33·3. Trench No. 3 is 50 ft. long, divided into two almost equal parts, A and B. Part A is 24 ft. long, 5½ ft. wide, and 5 ft. deep. In part B there are such large blocks of bauxite at the surface or immediately below it that sinking was discontinued at 2 ft. In part A the material thrown out consists of small blocks and pieces of bauxite, together with red soil mixed with innumerable particles and nodules of bauxite from less than the size of a pin's head to that of an orange. The total quantity of bauxite in this rubble is considerable, but it has not been included in the estimate, which gives bauxite about [illegible] of the total mass.

From the granular character of the red material, like soil, occurring among the massive bauxite Mr. K[illegible] formed the opinion that the greater part of it, if not the whole, was incoherent bauxite. Samples for analysis were collected, but they were lost in transit to England. Further samples were obtained during [illegible] and taken to England in September. The material was sieved through a 40-mesh sieve, and the coarse and the fine portions are now being analysed separately. There is little doubt that all of the coarse material is bauxite, while much of the fine material shows the same granular character as the coarse, and comprises about 5% of the whole of the interstitial material. Thus, of the whole of it among the massive bauxite about 95% consists of granular bauxite; and since each of the two kinds, namely, the massive bauxite and the rubbly loose matter, may be taken as approximately 50% of the whole mass, the latter represents about 2·5% of the whole. One partial analysis has been received to date. This shows: silica, 17·[illegible]; alumina 38·17%; ferric oxide, 20·94%; titanium oxide, 1·[illegible]; and water 20·36%. A rational analysis of this sample gives: free alumina, 24·5%; combined alumina, 13·7%; and quartz, 1·4%; so probably nearly the whole of the silica shown by the partial analysis exists combined with the 13·7% of alumina in the form of clay. Should the additional analyses give similar results, and assuming that the whole of this clay be removable by elutriation, the alumina in the residue would be about [illegible]. This does not take into consideration the ferric oxide, some of which exists in the form of the hydrate. If so, washing should remove it, and then the percentage of alumina in the residue would be correspondingly increased. The average of seventeen analyses of this massive bauxite is as follows: alumina 60·55%, ferric oxide [illegible], titanium oxide 2·21%, silica 1·42%, moisture [illegible], with a little lime and magnesia, together less that 1%. By the caustic soda process of conversion of bauxite into alumina, ore of this grade should give 75% of alumina, or 40% of aluminium.

Other deposits are also known in the district.

THE SULPHIDE CORPORATION'S LEAD REFINERY.

In our last issue we quoted two papers read at the 1918 meeting of the Australasian Institute of Mining Engineers describing the smelting and pot-roasting plants of the Sulphide Corporation at Cockle Creek, where the lead concentrates from the Central Mine, Broken Hill, are treated, together with custom ore and concentrate. Herewith we quote from another paper, read at the same meeting, describing the lead refinery, written by R. E. Cowles.

The lead refinery building is a lofty, well-ventilated one of hardwood frame, with galvanized iron walls and roof, and consists of five spans running north and south, covering a total length of 236 ft. Each span is composed of nine bays of 13 ft. centres, making the total width of the building 117 ft. It is situated conveniently at a distance of 100 yd. from the smelters. Through the third span of the building runs a 5 ton electric overhead travelling crane, of a 3 motor type, with a span of 29 ft. The crane runway extends over a railway line, which connects the smelters to the refinery. This crane is used for handling bullion, coal, melting kettles, lead pumps, &c. A 3 ton crane of similar type, but with a 50 ft. span, runs through the fifth span of the building, and also extends over the railway line already mentioned. This crane is used to load the soft lead into railway trucks, or to stack lead awaiting shipment in the area covered by the crane's operations.

The installation is in two units in parallel, each unit consisting of: one 50 ton copper-drossing kettle, one 40 ton antimony softener, two 44 ton desilverizing pans, one 40 ton refiner, one 38 ton market kettle, one moulding ring; and common to both sets: one small furnace for working up skimmings and drosses, one antimony dross furnace, one gas-producer for retort-furnace, one four-bottle regenerative gas-fired retort-furnace, two single bottle oil fired tilting retort-furnaces, three concentrating cupels, two finishing cupels, electrolytic parting plant, gold and silver melting furnaces.

The 44 ton desilverizing kettles and 38 ton market kettles are handled on special runways, centred over their respective kettle settings. These runways are carried on two 14 in. by 7 in. Oregon beams supported on C.I. brackets and, spiked to these 14 in. by 7 in. beams, are the rails which carry a ball-bearing crawl. To this crawl is suspended a tackle, from which are hung slings to lift the kettles. The travelling of these is done by hand, but is easily operated by one man. Ordinarily, these crawls are used to hang and travel the Howard presses and stirrers.

There are three working-floor levels in this building: No. 1, on the dump level, known as the cupel refiner parting room and firing-floor level; No. 2, on a level 3 ft. [illegible] in. lower than this, known as the moulding and soft lead storage floor; and the other, No. 3 floor, being elevated 7 ft. above the No. 1 or refiner floor. This elevated floor is known as the top floor, and is the one from which the melting kettles, softeners, desilverizing kettles, &c., are worked. This floor is built in reinforced concrete, with indented bar reinforcement. It is designed to carry 12½ cwt. per super ft., having 12 in. by 12 in. columns on 3 ft. 6 in. sq. footings. The beams are 24 in. by 12 in. up to 27 in. by 15 in., according to span. The floor proper has a total thickness of 9 in., 8 in. of this being 4-2-1 mixture, the other inch being a specially finished floating coat, laid while the main body was still plastic. The advantage of the elevated floor is that it allows a more perfect ventilation for the men engaged working on the No. 1 floor level, and also provides storage space for the various material used in connection with the operations. It also shows easy access from one end of the building to the other. The various furnaces are connected to three stacks of similar construction through the three main parallel flues running underground.

The base bullion, after being drossed and moulded (25 bars per ton) at the smelters, is run on trucks via a low-level railway, direct to No. 1 electric crane, slung and hoisted in two-ton lots to the copper-drossing kettles. The bars are charged into the kettle, melted at a low temperature, and the copper dross skimmed. This dross is treated in a small liquating furnace, and the liquated bullion returned to the refinery, the copper dross going to the smelters. The molten metal in the copper-drossing kettle is then transferred to the antimony softener by means of a direct-coupled electrically-driven Rumsey centrifugal pump. These pumps are an innovation in Australian refinery practice. The pump is permanently fixed in a frame, which rests on the circumference of the kettle, and so arranged that, when in position, the pump is immersed to the full depth of the kettle. The casing is provided with spacing studs to keep it from actually resting on the bottom. The time of pumping 40 tons is twenty minutes.

The antimony softener is the usual reverberatory type, water-jacketed, and lined with magnesite bricks at the litharge level; the end jacket is centrally channelled, the channel leading into a removable inclined spout, carrying the litharge into portable slag pots. After charging, fhe furnace is strongly fired, giving an oxidizing atmosphere, the resultant litharge being constantly run off at the channel and acting as a vehicle for carrying off the antimony and arsenic. Towards the end of the operation the furnace is allowed to cool back, and the crust of litharge is skimmed by hand. The further treatment of the antimony and arsenic dross will be referred to later. The operation takes, according to the antimony and arsenic contents, from eight to twelve hours, from time of charging to time of discharging into the desilverizing pans.

When clean the metal is tapped into one of two desilverizing pans, and the gold and silver separated by the Parkes process. No attempt is made to separate the gold and silver in the crusts, the whole alloy being mixed and retorted. The gold and silver contents are very variable, but only two zincings are made. The spelter is added in cakes, melted on the surface and stirred in mechanically by means of the Howard rope-driven stirrer. The first zinc alloy is pressed off by the Howard press, which is worked by pneumatic pressure, and conveniently handled by an air hoist supported by a carriage on overhead runway. The second zincing is skimmed by hand. The pressed alloy goes direct to the retorts.

The desilverized lead is then syphoned to the refiner, of the usual reverberatory jacketed type, on the lower floor, and the zinc and any remaining antimony are removed as a dross by skimming. The refined lead then passes by gravity to the market kettle, from which it is syphoned into a pot and runner, and moulded in a semicircular rake of hundredweight moulds, further skimmed and trimmed, weighed, stacked by means of an electric crane, and is then ready for shipment.

The skimmings from the antimony softener are stacked, and treated periodically in the antimony dross furnace, a furnace with refractory lining, but no water-jackets. The material is charged in 3,000 lb. lots, mixed with sufficient fine coal to reduce the bulk of the metal, the antimony and arsenic remaining in the slag. The slag and metal are periodically run off, the former into a bed, the latter into a five-ton kettle, from which it is moulded into bars and returned to the copper-drossing kettles. The slag, when cold, is broken up and further treated in a small blast-furnace, the metal carrying the antimony and a trace of arsenic. This antimonial lead is melted in a kettle, and the antimony percentage is reduced by dilution with refined lead to the requisite quantity for marketable shrapnel lead, and moulded into dumpy hundredweight bars.

Returning to the pressed silver-zinc alloy from the desilverizing kettles, this is charged in 12 cwt. lots to the inclined bottles of the gas-fired retort-furnace, the zinc distilled and condensed, and the retort bullion ladled into moulds.

The two tilting retort-furnaces are a special feature of the plant, and are worked by one attendant. Each furnace is supplied with a low-pressure burner using oil from the Mond gas plant. This oil, which is also used in the gold and silver melting furnaces, is a heavy distillate from the tar, and has proved very efficient. The amount of oil used is 26 gal. per shift of eight hours. One charge of 10 cwt. of alloy is finished each shift. The retorted bullion from the tilting furnace is lower in zinc than that from the gas-fired retorts. The life of the retorts in the tilting furnaces is very good, and for simplicity of operation the furnaces are a great success. When ready, the molten metal, instead of being ladled as in the case of the ordinary retort, is poured by tilting the furnace direct into moulds placed at the requisite height on a stepped portable frame. The retorted bullion, assaying 2,000 to 2,500 oz. Ag per ton, passes to the concentrating cupels, where it is worked up to concentrated bullion, the lead passing off as litharge, which is granulated in water, the final alloy containing approximately 16,000 oz. silver and gold per ton. The charge held by the cupel or test increases with use from 10 cwt. to 14 cwt. The concentrated metal is ladled into moulds and transferred to the finishing cupel. Here it is worked up to doré, which may undergo a further transference to a drying cupel, that removes the last traces of lead by absorption. The pure doré is then ready for moulding for the parting operation into anodes; these are rectangular plates about ½ in. thick, weighing approximately 100 oz.

The electrolytic parting plant is furnished with 36 earthenware cells of the Balbach type. Each cell contains two wooden paraffined cradles with inner frames, holding the cloths (10 oz. linen duck). The anodes lie horizontally on the cloth, and are just immersed in the electrolyte. The electrolyte is essentially a solution of silver nitrate carrying as impurities a small quantity of lead nitrate and a considerable amount of copper nitrate. The solution is slightly acid, usually about 3 grm. per litre of free nitric. The current is passed to the anode by means of a contact piece (usually of pure Ag), and the silver deposited as pure crystalline metal on the carbon cathodes, which lie on the bottom of the cell. The silver is raked forward periodically and drained on the lip of the cell, withdrawn, washed in a separate wooden vessel, and stored loose in draining boxes. When comparatively dry it is bagged in very light calico bags, charged to a Morgan tilting furnace, and run into bars of 1,050 oz. The gold remains as a sludge on the cloths. This is dried, inquarted with three times its weight of silver, and re-parted to give a denser product. Any remaining silver is dissolved by boiling with concentrated sulphuric acid, the gold washed free of silver, and melted in a Rockwell oil-fired furnace into bars of about 600 oz. The silver is remarkably pure, assaying 999·9 fine and carrying only traces to 4 dwt. of gold per ton.

All kettles and furnaces, with the exception of the retorts, are fired direct with coal, but later on, no doubt, these will be heated by means of Mond gas. At present, however, the supply is not available, and it is impossible to build further producers until the supply of steel plates becomes more plentiful.

TERRESTRIAL MAGNETISM AND MINE-SURVEYING.

In our issue of September last, Professor L. H. Cooke drew attention to the influence of terrestrial magnetism on mine-surveying, and discussed the investigations on this subject made by Dr. Charles Chree ai Kew Observatory. Dr. Chree read a paper before the Institution of Mining Engineers last year entitled "Terrestrial Magnetism in relation to Mine Surveying." Professor Cooke contributed to the discussion on the paper. By permission of the Council of the Institution we are enabled to reproduce herewith Professor Cooke's remarks, which are published in Vol. LV of the Transactions.

Many misconceptions on this subject are current, and have even found their way into the text-books; thus, it is often stated that the needle points to the terrestrial magnetic poles; or, again, with greater appearance of precision of phrase, that the planes of magnetic meridians of different places intersect at the terrestrial magnetic poles; or, again, that the needle is subject here to violent disturbances which *frequently* amount to one or two degrees! Dr. Chree's paper will dispel many such foggy inaccuracies incidentally, but its chief service will be to shatter the blind unreasonable faith in the random misuse of the needle.

The main source of trouble is the reference of the surveys to a "mean magnetic meridian"; then follows the misconception that the "mean magnetic meridian" can be determined with a compass, a dial, or a compass-theodolite, despite the fact that the sighting plane (plane of collimation) of the instrument is never parallel with the zero-line of the needle-scale; that the geometric axis of the needle does not as a rule coincide with its magnetic axis; that the pivot is never exactly at the centre of the needle-ring; that the line joining the two points of the needle does not pass through the point of the pivot, etc. Naturally follows the crude notion that from a map of isogonals, or from a list giving the declinations at various places, or by application to a magnetic observatory, true or geographic north can be found by way of a knowledge of the mean magnetic declination. Dr. Chree specifically condemns two of these fallacious modes of proceeding, but the tale of errors will never be ended except by a more rational training and stricter testing of the mine-surveyor, a point made by Mr. W. H. Galletly.

Again and again, surveyors blame the instrument-makers because no two compasses will give exactly the same measure for the magnetic azimuth of the same draft. Professor Cooke has in his charge an instrument which has the trough compass attached 5⅓ degrees in error, but he considered its enormity a rare piece of good fortune; for even the most negligent of students could see that the instrument was faulty and be induced to interest himself in the simple and ready means of neutralizing the error, namely, by the aid of a line of orientation. A few years ago Mr. E. W. Newton, the well-known instrument-maker, of Camborne, Cornwall, showed Professor Cooke his records of tests of groups of needles, each group having been cut from the same strip of steel. When placed one after another in turn on the same pivot in the same compass, the readings they gave differed commonly by a few minutes up to about ¼ degree. The non-coincidence of the magnetic and geometric axes of the needle and the failure of the line joining the two points of the needle to cut the supporting point—one, or the other, or probably both together—were doubtless the causes—almost if not entirely irremediable. The orientation line, rationally used, cuts out not only the constructional blunders like that of the 5⅓ degrees just mentioned, but also these irremediable errors, as well as that due to the eccentricity of the pivot; and largely reduces errors arising from the regular and irregular changes in the position of the magnetic meridian.

The use of maps showing "smoothed" isogonals is recommended in error by almost all the recent British text-books on mine-surveying, a fact which lends force to Dr. Chree's warning; his further hint that even the unsmoothed isogonals of Nos 5 and 9 of the Rücker and Thorpe maps do not tell the whole truth, should help to keep surveyors from attempting to take a value for the magnetic declination from any such map, if the value is to be used in good work in mine-surveying. Here and there in some of the northern coalfields are volcanic necks piercing the Coal Measures; such bodies of more or less basic rock may cause local disturbance which will generally escape representation on small maps. Dumbarton Rock is such a neck (not in the Coal Measures) where a century ago a compass set up at various points on a straight line running nearly tangent to the neck showed very discrepant measures of the azimuth of the line. The late Mr. J. Henderson and Mr. W. Thomas have both called attention to great deflections of the needle they have encountered in their surveys of Cornish mines; and an acquaintance, when surveying a certain colliery, finds the magnetic meridian fairly abruptly departs from its usual position when passing from one part of the colliery to another part. Possibly in such cases of areal disturbance, the surveyor should make use of several lines of known orientation, as, for example, the lines of a triangulation system. Fortunately such local disturbances seem to be relatively rare in the collieries, but it would be of interest and value to learn whether the local disturbing agencies affect the temporary change (diurnal variation and irregular disturbance). In other words, whether the Kew data could be usefully applied in such cases.

Mr. W. G. Walker states that the effects of the rock, the presence of iron railways or electric currents in the mine, and secular and daily variation of the normal magnetic forces make the use of surface values even near the mine quite inadmissible underground. This might be discouraging if magnetic orientation were a thing born only yesterday; but it has had a scientific basis for three-quarters of a century in Germany, and the scores of successes attained are ugly facts for Mr. Walker's views. One striking example is worth quoting: mine surveyor Schmiedicke made an underground traverse between two plumb-wires suspended in shafts 550 metres (600 yards) apart, conditions which afford a trustworthy means of finding the azimuths of the drafts. Two drafts were afterwards oriented magnetically, with results as follows:

Draft	Azimuth from traverses	Azimuth by way of magnet	Difference in seconds
1 to 2	155° 31′ 08″	155° 30′ 42″	26
43 to 44	359° 15′ 32″	359° 15′ 37″	5

We cannot hope to approach such accuracy unless we adopt instruments with filar suspension of the needle. Apart from the body of evidence obtained in mine-surveying practice, the practical concordance of the regular and irregular variations of the declination at the surface and underground has been established by the synchronous tests organized by Bergrat E. Borchers in an observatory at the surface and in another 545 metres (596 yards) underground in the Eleonore mine, Clausthal, at intervals during the years 1843 to 1846. This was the first time that comparative observations had been made at so great a depth, and for their trustworthiness speaks the reputation of Borchers, a magnetician, an inventor and improver of mine-surveying instruments, appliances, and methods, and a scientific mine-surveyor whose wonderful results in practice were the admiration of his age. Earlier observations in the Freiberg mine, and later ones by Obermarkscheider Schmid and the magnetician Liznar for a depth of 1,000 metres (1,094 yards) in the deep Adalbert shaft at Przibram confirm Borchers' observations, and tend to show that Clausthal is not an exceptional case. So far the observations were at most made no more frequently than every 5 or 15 minutes, but in 1906 self-registering observatories were installed at the surface and 813 metres (889 yards) below, in the Monopol Colliery, Westphalia, and the tests were conducted by mine-surveyor Stiepel, who had been specially trained at Potsdam. No noticeable difference showed itself in the curves of the two stations on quiet days, or on days of irregular but slow disturbance, and no noteworthy discordance in the quicker swings. In 1903 L. A. Bauer investigated the possibility of operating self-registering instruments in the Lake Superior copper mines and found the conditions exceptionally good, in the absence of electric installations, at a depth of nearly a mile below the surface; but delay in the delivery and the defective character of the German instruments prevented the carrying-out of the work. Owing to electric installations, the conditions are no longer favourable. Mr. T. Russell, of the Great Lakes Survey, reported that in the Tamarack, 4,760 ft. below ground, the diurnal range of the declination and the times of elongations were about the same as those observed at the surface, while the dip was 27 minutes less.

From the body of evidence it would seem that we may arrive at the important practical conclusion that underground magnetic declination and its regular and irregular variations are much the same as at the surface if there is no great mineral or artificial disturbance; and the absence of mineral disturbance is fairly general in the coalfields.

But magnetic research is much wanted in disturbed areas whether shown in, or omitted from, the Rücker and Thorpe maps. Mr. V. Watteyne has called attention to the distortion of the plans of some Belgian collieries owing to the non-verticality or twisting of the magnetic surfaces of force; and Prof. Haussmann and his students in the Diepenlinchen zinc mine have shown that it is probable that the run of the magnetic lines of force at grass differs from their underground course.

But these irregularities seem to be rare exceptions, as rare as those for difference of elevation at the surface. One would like to know what correction Mr. Walker applies for difference of elevation in his surface surveys. Doubtless with every change in elevation or profundity there is some change in declination; but, according to the available evidence, the amount must be very minute whether man observes on the mountain-tops or in the mine-bottoms. Commonly in surveying in a district free from local disturbance one can rely on the same value of the declination holding good for a mile at the surface; and on *a priori* grounds one may believe that the change will be generally much less for a mile of depth than for a mile horizontally.

While the British Empire has allowed Germany a three-quarters-of-a-century start in magnetic orientation, her Roberts shaft-plumbing system stands well ahead of all other methods in the world for orienting an underground survey from a single, deep, vertical shaft independently of the needle. The optical methods appear to break down in depth, owing to difficulties of visibility, and perhaps also of air-refraction and reflection, which will give food for consideration of the Ordnance Survey when they are easily transferring the geographic meridian to the bottom of deep shafts. The optical plumbing method of the geodesian Nagel is no longer applied even in the county of its origin or in Austria, and its description has been deleted from the latest text-books. The method with the miner's transit-instrument which he has modified from the astronomical instrument (not the transit-theodolite or the misnamed American "transit") has a far surer scientific foundation and better chances of success. While this purely British method overtops all its optical rivals, and with the improvements introduced by Prof. E. Liveing and Prof. G. R. Thompson permits of reducing the mischaces of vibration, refraction, etc., by repetition and averaging, it halts at a moderate depth, owing to limitation of visibility, and awaits further aid.

More than one contributor to the discussion has questioned the applicability of the Kew data to the whole of the coalfields, and Dr. Chree himself states that science is so little advanced that he is not in a position to say what is the desirable number of observatories in this country. As the publication of the Kew data arose out of the writer's (Professor Cooke's) proposal to procure a self-registering declinometer for the Royal School of Mines and to extend the benefits of its records to the country, it is perhaps desirable to state the grounds on which that proposal was made. Apart from its educational uses for staff and students, it was hoped to stir up a greater number of surveyors in this country to take an interest in diurnal variation and irregular disturbance as a probable source of the occasional waste of their efforts or the occasional poor quality of their results. While one recording instrument was looked upon as a good and useful *beginning* only, it should be recollected that Rücker and Thorpe in their magnetic survey reduced to the epoch January 1, 1886, used a correction which was the algebraic sum of the diurnal variation at the local time and of the disturbance registered at Kew at the Greenwich mean time at which the observations were taken. They applied the Kew data over the whole of the British Isles, a much greater area than that of the coalfields, and, as a test of the validity of their procedure, they picked out stations in Ireland and Scotland, where two or more observations were made at times when the diurnal variations differed by more than 4′. Taking the extreme western and northern stations, for Westport they found the values 23° 5·5′, 23° 4·2′, 23° 5·4′; for Portree, 23° 21·6′, 22° 22·7′; and for Stornoway 23° 50·7′, 23° 48·4′, 23° 50·7′. The results for the coalfields, which are all nearer Kew and in perhaps less-disturbed localities, should be no worse, and may be better.

The late Prof. Brathuhn arranged a number of orientations at mines in the Harz in the neighbourhood of the Clausthal Observatory, in the Mansfeld copper district, near Barsinghausen, etc. The results were corrected in duplicate for diurnal variation and disturbance from the data provided both by the Clausthal Observatory at distances of from 7 to 62 miles, and by the Wilhelmshaven Observatory at the much greater distances of from 94 to 204 miles. The greatest difference of any pair of results reached only 47 seconds of arc, and the average difference of twenty-six results 18 seconds. Brathuhn thought in 1888 that he was entitled to draw the conclusion that a good central observatory in Clausthal would satisfy the requirements of mining and mine-surveyiug of the whole of Prussia. However, the lapse of time and further experience made him less confident, and in 1892 he wrote that if important orientations were in hand, the time from 10 a.m. to 2 p.m. should be avoided, because the change in the position of the needle, owing to the diurnal variation, was at a maximum in these hours, and places east and west might suffer from the difference of local time and consequent non-concurrence of the diurnal variation. In the later editions of his Lehrbuch der Markscheidekunst (see, for instance, the fourth edition, 1908, page 364) he extends his ban over the time from 6 a.m to 3 p.m., unless the declinometer is in the immediate neighbourhood ; he would have distant curves used only for evening and night-work, and then only if there were no disturbance.

Brathuhn probably had in mind the attainment of such fleckless results as those of Schmiedicke. As Dr. Chree's invaluable tables show the relative infrequency of disturbances in the morning hours, and as Rücker and Thorpe's corrections were fairly successful, it is possible that the Kew data may suffice—between 2 a.m. and noon—for most of our mineral fields. However, in the night-hours electric trams stop running and much other electric work ceases.

As irregular disturbances occur on the majority of days, and as the method of smoothing the curves tends to conceal the smaller vagaries of the magnet, a very great increase in the accuracy of the corrections for the fluctuations of the magnet would be secured if the Kew authorities would issue the actual declination curves smoothed only as regards artificial electric disturbance.

As the irregular disturbances and the ordinary diurnal changes in the northern and Scottish coalfields are slightly larger than those of the south, a further increase in the accuracy of the corrections would result if the declination curves of Eskdalemuir could also be published.

Proportional interpolation for places situated in the Midlands, etc., with, perhaps, a slight further correction of the ordinary diurnal change for the difference of time or longitude, would probably give all the accuracy desirable for most of the important work of the surveyor. A better way of interpolating may be possible later. His most difficult tasks, however, would demand the use of two instruments, especially, perhaps, in disturbed areas.

In any case, the use of a surface line of known orientation is desirable for comparison ; and if surveyors would use the better-class olds methods of orientation, compare their results with those corrected by the light of the Kew data, and publish their results, some guidance would be obtained for the future as to where scientific research could be best applied. The actual curves of Kew and Eskdalemuir would enable the surveyor to take out corrections to his magnetic azimuths for any 5 minutes of the day, and would reduce the uncertainty in the magnetic angles nearer the very desirable figure of 1 minute of arc. At the present time, perhaps, we can hardly expect such an expense to be incurred ; but on the resumption of more normal conditions the suggested improvement will doubtless receive the consideration of the Meteorological Office. Meanwhile, in addition to the two-hourly averages, or in place of them, the values of the Kew and Eskdalemuir declinations for points of time (not averages for 2 hour or other lengthy spells), should be published. Professor Cooke suggests that the values for 7, 7-30, 8, 8-30, 9, 9-30, 10, 10-30, and 11 a.m. (G.M.T.) should be given. However, he has known many diallers to find it convenient to survey in the afternoon and evening and night, and although their hours are more liable to disturbance than those of the morning, it might be well to issue observatory values for such times, but at less frequent intervals. Moreover the possible freedom of the night-hours from troubles due to electric power is to be taken into consideration. Professor Cooke concluded by paying a high tribute to Dr. Chree for his work

THE HEIDELBERG GOLDFIELDS

We continue our abstract of a series of articles appearing in the *South African Mining and Engineering Journal* giving a history of the Heidelberg goldfields. In the last issue the abstract ended with the publication of Dr. E. T. Mellor's theory that the workable reef of the Far East Rand basin is a continuation of the Main Reef Leader of the older part of the Rand.

Dr. Mellor's lecture was almost immediately followed by a challenge on the part of Mr. Bleloch. Mr. Bleloch threw down the glove on the grounds that Dr. Mellor was reported to have defied "all unorthodox geologists and prospectors and less learned observers" to pick out Main Reef Leader banket from among a mixed lot of Main Reef Leader and Van Ryn foot-wall reef." Mr. Bleloch claimed his ability to separate in a similar way "specimens of Van Ryn Reef from specimens of Nigel Reef provided that in each instance the specimens had portions of the foot-wall shale attached.

Dr. Mellor's findings in regard to the identity of Nigel series with the alluring attractions of the Main Reef Series and the reefs worked in the Modderfontein-Van Ryn area soon began to be applied to support and foster commercial enterprise. Thus in July, 1916, the directors of the Oceana Development Company announced that information had been received that the extension of the Nigel (or Van Ryn) Reef had recently been located on the farm Platkoppies No. 63, south of Heidelberg township, and fully 30 miles south of the Daggafontein shaft. The reef was reported to be well defined, and, where struck, to have assayed 36 dwt. over a width of 14 inches. The statement added that the interest of this information to shareholders was the accumulating proof that the company's farms Eendracht and Koppieskraal were well within the area of the extension of the reef now being worked by the principal companies in this district. [Readers are referred to the map in the June issue which shows the positions of the farms mentioned in this abstract.—EDITOR.]

But it was also evident that there were those whose opinions were in contradiction to Dr. Mellor's and who did not hesitate to back their heterodoxy with cash. Thus we find that in April, 1916, it is recorded that the findings of the Geological Survey were not generally accepted by prospectors and others for practical purposes. This related to the pegging of 300 claims supposed to contain the Van Ryn Reef along the southern boundary of the New Rietfontein company's property on a line assigned by the Government Geological Survey to the Government Reef series. Also with regard to the Southern Van Ryn Co. the news was : "We are officially informed that this company's bore-hole No. 4 has attained a depth of 770 ft. After passing through the coal measures with about 15 ft. of Dwyka conglomerate at the base the drill entered Witwatersrand quartzite at 60 ft. and from that depth downwards has exposed a typical section of the beds usually found overlying the Van Ryn series, that is, the beds between the Chimes series and the Van Ryn. No shales, beds, or dykes have been encountered, and only three small pebble beds of less than six inches in width were found down to 770 ft. At 770 ft. a banket leader, six inches wide, was cut, and at 772 ft. a section of thirty inches of quartzite with scattered pebbles and containing three distinct bands of reef."

The Southern Van Ryn Reef had been registered in March, 1915, to acquire 1,000 claims on the farm Varkensfontein 217 in the Heidelberg district. Other claims were subsequently acquired, and to-day this company possesses an area equal to 1,661 claims on Varkensfontein and Draaikraal. The original geological thesis upon which this company was floated was that it contained both the Nigel and Van Ryn Reefs. The leading promoter of the enterprise was Mr. W. E. Bleloch, so that it is not difficult to understand Mr. Bleloch's opposition to Dr. Mellor's identification of the Van Ryn and Nigel. Mr. Bleloch crystallized the importance of his contention at the last meeting of the Southern Van Ryn, when he declared: "The Nigel Reef has been worked for 30 years by the Nigel Gold Mining Company and the Sub-Nigel, and, generally speaking, it is a thin reef with well developed pay shoots, which brings the grade of ore above the average. This reef has been found to carry 30% to 35% of these pay shoots in a given area, but the reef is thin and the tonnage found in the pay shoots in this reef is not very great. As an example, the Sub-Nigel after a good many years' working has only 400,000 tons of payable ore developed on the Nigel Reef, whereas in the great mines to the north, such as Government Areas and New Modder working the Van Ryn Reef, the tonnage of payable ore runs into many millions, and it means that if such development continues at that rate the value of the Government Areas mine will run to £100,000,000."

It is not surprising that Mr. Bleloch attaches much greater importance to the Van Ryn Reef than to the reef worked in the Nigel mine, and he is not alone in his desire to draw attention to it. For instance, the Sub-Nigel, Ltd., in the report for the quarter ended September 30, 1916, states: "It will be noted that the reef upon which this company is working is in this report described as the Van Ryn Reef instead of as the Nigel Reef as heretofore, as it is accepted by our engineers that the reef in question correlates with the Van Ryn Reef as recognized in the large and well-known northern mines of the Far East Rand."

The Platkoppie Syndicate was registered so long ago as 1909, but it does not appear to have sought much notoriety or importance until the late Dr. Corstorphine reported in favourable terms on the property in the middle of 1916. In the course of his report Dr. Corstorphine dealt with the theory of the identity of the Nigel-Van Ryn and Main Reef Leader. He wrote: "It has often been urged against this correlation (1) that at Nigel there is only one reef, instead of the three typical of the Main Reef Series on the Central Rand, (2) that the one reef is a very narrow one, and (3) that it rests on a slate foot-wall, which is never the case on the Central Rand. All of these objections are sufficiently answered by the fact that in the Far East Rand mines the gradual replacement of the sandstone or quartzite foot-wall by slate can be traced, and there too the thinning out of the reef series is shown in the mine workings. Dr. E. T. Mellor has recently correlated the ore reef of the eastern portion of the Rand with the Main Reef Leader of the Central Rand, a correlation which may be accepted for the Nigel district also. Several reefs have been traced through the farms Nooitgedacht, Elandsfontein, and Platkoppie by Mr. John Moffat, on behalf of the Platkoppie Syndicate, Ltd., and on the two last-named farms he has exposed the reefs by trenching and prospecting shafts. There is some old prospecting work on Nooitgedacht and on the northern portion of Elandsfontein, but the continuation of the Nigel Reef on the southern part of Elandsfontein and on Platkoppie is exposed for the first time in the present prospecting work. This means that some four miles of unprospected outcrop have been added to the stretch previously known and partly prospected."

Following on this report came the flotation of the Platkoppie Exploration Company with a nominal capital of £20,000 to test the value of the areas referred to by Dr. Corstorphine. These two concerns—the Platkoppie and the Southern Van Ryn—in the geological premises upon which they have been floated crystallize the whole issue of the modern controversy. The former represents the view that there is one reef and one reef only, which has been proved by experience to contain gold in payable quantities over such large areas that wherever it may be found the chances are that a profitable mine will be developed. This reef is the Nigel-Van Ryn-Main Reef Leader, the varying names being merely local designations and the identity of all three are vouched for by the most distinguished geologists of the country. On the other hand we have the theory, of which Mr. Bleloch is the sponsor, that not only the Southern Van Ryn but a vast area of the Far East Rand contains the Van Ryn Reef overlying the Nigel; that there are, in fact, two profitable conglomerate bodies of which the upper or Van Ryn is infinitely more valuable.

It should here be pointed out that while Mr. Bleloch would appear to have obtained very little encouragement from present-day geologists and mining engineers, his theories have found a certain measure of support from no less an authority than Dr. G. A. F. Molengraaff, formerly State Geologist. Mr. Bleloch, writing to the directors of the Houtpoort, Ltd., on November 5, 1918, said: "I will present the following statement by Dr. Molengraaff, a geologist of world-wide reputation. I will add that I have the same opinion stated in writing by the late Mr. J. S. Curtis, another eminent geologist, formerly of the Geological Survey of the United States, who had over a quarter of a century's experience of these Witwatersrand reefs, and I will add that this is the opinion originally held right from the early days of the Rand and it is the opinion still held by the great majority of mining men with practical experience. Dr. Molengraaff's letter is dated Delft, November 27, 1911. In it he states: 'I quite agree with you about the Far East. I also think that portion of the basin too shallow to give enough space for such thickness of the strata of the Witwatersrand system as would include the Main Reef. *I also only [illegible] Lower Witwatersrand beds there.* That is to say that the Van Ryn Reef and the Nigel, [illegible] reefs of the Far East Rand, are deposits whose geological position is in the Lower Witwatersrand beds and that therefore they are older and quite different deposits from those of the Main Reef Series, whose geological position is in the Upper Witwatersrand beds."

Mr. Bleloch in 1916 induced the Houtpoort, Ltd., a concern which was originally registered so long ago as 1903, to revive its interest in the Heidelberg area and to take over under option contract the farms Goedverwachtij and Klippoortje. At later dates the Eastern Van Ryn and Modderfoniein Gold Mines, Ltd., entered the arena, and to-day we find the Heidelberg Town Lands and the farms Tulipvale, Eendracht, and Boschfontein involved in the controversy. On these properties work is being undertaken with a view to demonstrating the truth of the "two-reef" theory. But activity has by no means stopped at this point. It has swept onward over the Balfour area.

Meanwhile it should be recorded that in the early part of 1916 the Daggafontein Gold Mine passed into the control of the Consolidated Mines Selection Company, which had successfully developed the Brakpan and Springs properties and was thirsting for fresh conquests. Another important change in control took place a year later when the Consolidated Gold Fields of South Africa became interested in the Southern Van Ryn and assumed financial and technical control of that property. The latter action did not, however, imply that the technical advisers of that corporation endorsed Mr. Bleloch's view. On the contrary, it has recently been decided to sink a deep level shaft to intersect the "Nigel-Van Ryn-Main Reef Leader" in depth. Mr. Bleloch, speaking at the meeting held on January 31 last on this point, agreed to Mr. Leslie's programme only on his assurance that he had an open mind on the question of the Van Ryn and Nigel Reefs and that development will be done on the Van Ryn Reef when intersected in the shaft. The decision to sink a deep level shaft on the Southern Van Ryn has caused considerable disappointment to many shareholders who had been told that they had an outcrop proposition, and it has been the cause of reviving interest in the controversy. From the point of view of the economic exploitation of the Nigel Reef the location of this shaft is sound policy, but as against that it is contended that for the Southern Van Ryn, with its not excessive cash resources, a more sound project would be the immediate development of the reef which has been exposed at surface and on which a certain amount of preliminary development work has been carried out. It is again a question of the two-reef theory as opposed to the declaration that there is one and one only payable reef section in this area. [Since the above was written the Gold Fields has given up control.—EDITOR.]

Previously to the acquisition of an interest in the Southern Van Ryn by the Gold Fields, a considerable amount of preliminary development work was done. The report of the manager for the period ended with October 31, 1917, stated "that considerable prospecting in the shape of bore-holes and shafts had been done on the property previous to my taking charge, and data appertaining to work that was done on the property some twenty or more years ago have been found. I refer to the Henderson shaft, which is situated on this property, close to its southern boundary. We now have information to the effect that a reef of 18 ft. in thickness and assaying 5½ dwt. was encountered in this shaft at a depth of 200 ft. Of course, in those days these values were not considered payable, and no one would think of working them, but it is a very different matter to-day; this reef could be worked now and a very decent profit made from it. Eight bore-holes in all have been put down on this property in various places, ranging in depth from 122 ft. to 1,600 ft. Five of these bore-holes have intersected the pay reefs—Nigel and Van Ryn—and gone into their respective foot-wall shales. Four prospecting shafts have been sunk to the sub-outcrop of the Nigel Reef, and in every instance the reef was located at 60 ft. from the surface, or less. No. 1 shaft was sunk to a depth of 77 ft.; at 60 ft. the reef was intersected, dipping at 65°. A cross-cut to pick up the hanging leader was then started to the west; this leader was intersected at a distance of 30 ft.; work was then stopped in this shaft. No. 1 main shaft on the Nigel Reef is located 100 ft. south of No. 3 prospect shaft, dipping at 62°, and should encounter the reef at a depth of 69 ft. No. 1 incline shaft was sunk to a depth of 160 ft., and then stopped according to instructions received from the consulting engineer of the Consolidated Gold Fields. The reef was intersected in this shaft at 83 ft.; the following figures give depth, width, and values:—At 83 ft., 9 in. wide, assaying 1·00 dwt.; 85 ft., 24 in., 2·50 dwt.; 88 ft., 12 in., 13·70 dwt.; 90 ft., 16 in., 12·50 dwt.; 92 ft., 18 in., 7·50 dwt.; 94 ft., 15 in., 6·20 dwt.; 96 ft., 12 in., 3·75 dwt.; 98 ft., 18 in., 6·30 dwt.; 100 ft., 12 in., 5·40 dwt.; 105 ft., 14 in., 4·39 dwt.; 110 ft., 12 in., 10·00 dwt.; 115 ft., 14 in., 2·54 dwt.; 120 ft., 15 in., 6·04 dwt.; 125 ft., 18 in., 3·10 dwt.; 130 ft., 18 in., 7·45 dwt.; 146 ft., 21 in., 4·99 dwt.; 150 ft., 36 in., 2·07 dwt.; 155 ft., 36 in., 2·17 dwt. No driving was done on the reef in this shaft. Quartz veins were scattered through the reef exposed. These veins decreased the values very considerably, as it was impossible to section the reef without intersecting them; at the same time they were conclusive evidence that the shaft was being sunk in a disturbed zone. It is believed, however, that this disturbance is purely local. When the technical control was assumed by the Gold Fields no further work was conducted in the shafts referred to and operations were centred on the sinking of a deep-level shaft which, according to the plans of the Gold Fields engineers, would cut the Nigel Reef at a depth of 3,000 ft. or more. The Gold Fields apparently are disciples of the orthodox school of thought. Their technical advisers do not or have not yet recognized the claims of the two-reef theory, and accordingly the No. 1 incline shaft which certainly was in auriferous conglomerate at its lowest depth and had been in ore from 83 ft. downward was closed down, much to the disappointment of the original and present shareholders.

The Daggafontein property, after extensive diamond-drilling and shaft-sinking, is developing from its No. 1 shaft a reef lying on a shale foot-wall. This ore-body Mr. Bleloch correlates with the Nigel. Both this No 1 shaft and the No. 7 bore-hole, almost on the site of which the shaft was located, are claimed by Mr. Bleloch to have passed through a reef which he terms the Van Ryn but which has apparently been regarded by the management as the Kimberley. In the No. 1 shaft the bottom reef was separated by 280 ft. of quartzite from the bottom of the diabase, whereas in the No. 7 bore-hole, which is not more than 100 ft. away from this shaft, only 60 ft. intervenes between the bottom of the diabase and the lowest reef series which is termed by the management the Main Reef and by Mr. Bleloch the Nigel. In each instance a reef was passed through at approximately 2,100 ft. In the bore-hole this particular reef assayed 18 dwt. to the ton, but records as to the value of this reef where intersected in the shaft are not available. This bed of conglomerate is assigned by the management to the Kimberley series By Mr. Bleloch it is termed the Van Ryn.

Immediately south of Daggafontein lies the triangular shaped farm Vogelstruisbult of the Rand Mines and Consolidated Gold Fields, into which Vlakfontein of the Lydenburg Gold Farms intrudes. To the west of the Vogelstruisbult is Vlakfontein of the Lace Proprietary Mines, and immediately south is Grootfontein of the Consolidated Gold Fields and the farm Varkensfontein, on the northern portion of which the Southern

Van Ryn Reef G.M. Co.'s property, while the southern portion is held by the Sub-Nigel and Nigel G.M. Cos.

The farm Marais Drift No. 4 lies immediately to the south of Noycedale (Ryan Nigel G.M. Co.) and east of Spaarwater 154 (Lace Proprietary Mines-Barnato Bros.) and of Klipportje 288, on which the New H.E. Proprietary have interests. The greater part of Marais Drift is held by the Amalgamated Properties of Rhodesia, Ltd., now the Rhodesian Exploration Company, and African Farms, Ltd., while the south-eastern corner is under the control of the Consolidated Gold Fields of South Africa. A good many years ago a fair amount of work was done on this property on its eastern side. Two incline shafts put down in this portion of the property exhibit a reef lying on a shale foot-wall and there can be no doubt that the banket bed disclosed in this shaft is correlative to the reef worked in the Nigel and Sub-Nigel mines.

About the middle of Marais Drift the reef appears to have taken a gradual bend to the east, judging from the old workings on the Gold Fields section of the property. It is, however, contended by one or two geologists that the true line of the Nigel lies to the west of the old Gold Fields workings and that the reef disclosed on the southern portion of Marais Drift is not the Nigel at all. This reef would then appear to cross the extreme south-west corner of Rietpoort No. 89 and continue through that portion of Poortje No. 125, in which the Crown Mines have an interest through their absorption of the old Paarl Central assets. Here, too, the Consolidated Mines Selection (otherwise Rand Selection Company) is in possession of a portion of Poortje. On this latter area prospecting pits were sunk long ago on the line of the reef discovered to the north, and the reef has been disclosed as a comparatively thin body of conglomerate lying again on a shale foot-wall. It is found again on Houtpoort, maintaining an approximate north and south line of strike, and a flat dip to the west. Between Poortje and Houtpoort, and almost in a line with the township of Heidelberg, it is contended that the line of this ore-body takes an S-shaped curve and after traversing the farm Bothaskraal No. 207 is to be found on the extreme eastern side of Blinkpoort 253, recrossing Bothaskraal and the southern portion of Poortje 125 with an approximate E. and W. line of strike and a dip to the north. There are old workings approximately on the corner of this bend to the south-east of Heidelberg on the main road to the Free State, but the delvings of the workers of more than two decades ago seem to have come to naught from the point of view of material output.

(To be continued).

Tin and Tungsten Research.—The report of the Tin and Tungsten Research Board for the year ended March 31 gives details of the progress of the investigation. We have already quoted Professor Truscott's results in connection with slime concentration, in our issues of December, 1917, and March, 1919. We reproduce herewith other parts of the report.

The examination of the physical condition of cassiterite in Cornish lodes has been continued by E. H. Davison, of the Mining School, Camborne, throughout the year. He has examined a large number of sections of lode material with the aid of the microscope, and finds that most of these contain fine cassiterite particles so minute in size as to be difficult to save in dressing operations. Certain clearly marked types of veinstone were recognized, readily distinguishable from one another. His investigation is not yet complete, but his report will probably be ready for publication in a few months. H. W. Hutchin, assisted by L. J. Meade, has begun a parallel examination with the microscope of the grains of cassiterite in certain mill products.

The treatment of complex low-grade refractory materials, such as "tinny iron" or "black iron," by fusion with nitre cake has been investigated by H. R. Beringer, Captain A. M. Drummond, and F. H. Mitchell. They found in the laboratory that by fusion at a red heat and treatment of the melt with water, the iron and tungsten passed in great part into solution and the cassiterite remained in the residue in a suitable condition for recovery on the dressing floors. An experimental reverberatory furnace with a flat cast-iron bed was built at the King Edward mine, and about a ton of refractory material from East Pool treated, with promising results. A furnace of larger capacity but different design is now in course of erection by the management of the South Crofty mine with the object of utilizing the process. There seems reason to expect that the remaining difficulties will be overcome and that the nitre cake process will be available for treating such complex refractory low-grade concentrates, which at present realize little or nothing, involving a loss of many thousand pounds a year in the country. The same investigators have also been engaged in endeavours to find a chemical method of removing and recovering the tungsten from concentrates as they leave the calciner and from certain ores containing wolfram, and have had most success with a modification of the Oxland process. It does not appear at present, however, that the method can be applied industrially.

Dr. O. J. Stannard has succeeded in separating tungstic acid in a remarkably pure form by a new process from concentrates and wolfram ores. Further work is required before his method is ready for tests on a larger scale. Details will be forthcoming as soon as protection has been secured.

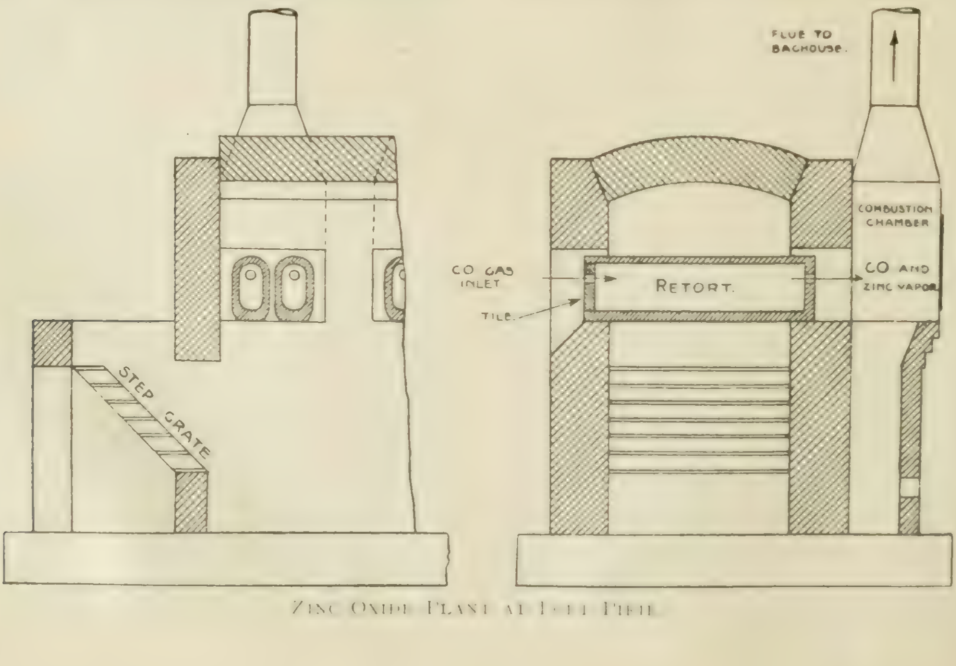
H. W. Hutchin, assisted by L. J. Meade, made experiments on the recovery of tungsten from concentrates by digestion with solutions of caustic soda, and found that dilute solutions were ineffective, a point confirmed by independent work by Mr. Beringer. Strong solutions, however, acting on uncalcined material effected what was apparently complete extraction of WO_3, the extraction from calcined material being incomplete. Further prosecution of this inquiry has been suspended, as economic success appears to be unlikely.

A process devised by E. W. Janson and H. W. C. Annable for the recovery of tin has been carefully examined, the tests being watched by J. H. Goodchild. The method is promising, and extracts the tin from finely divided cassiterite more readily than from coarse particles which can be easily saved by ordinary ore-dressing methods. It is proposed to make further efforts to develop the process, and to examine certain modifications of it which present themselves.

Platinum in Rhodesia.—A short report has been issued by H. B. Maufe, director of the Rhodesian Geological Survey, on the occurrence of platinum metals in the Somabula diamondiferous gravels. The gravels which contain the diamond and numerous gemstones are found almost on the main watershed of Southern Rhodesia close to Willoughby's Siding and about 12 miles south-west of Gwelo. An examination of the pebbles composing the gravels revealed the presence of chromite and chromite-bearing rocks in appreciable quantity; and, therefore, the possibility that the rocks might contain platinum or metals of the platinum group, namely, iridium, osmium, palladium, rhodium, and ruthenium. The late Mr. Zealley, in writing of the occurrence of platinum in Southern Rhodesia, said : "The Somabula gravel for instance is a likely source, since it is known that much heavy material is concentrated therein, and that a considerable proportion of the pebbles are from ultra-basic rocks ; thus pebbles of chromite rock are abundant, and many of the chalcedony pebbles can be recognized by the practised eye as silicified serpentines derived from the Great Dyke and from the ancient schists. The fine heavy black gold-bearing sands concentrated from the Somabula gravels apparently have not been examined for platinum. The finest material should preferably be tested." A sample of the heaviest fine concentrate obtained in the washing for diamonds was sent to the Imperial Institute to be assayed for platinum metals. Under date February 17, 1919, the director of the Imperial Institute reports the following results : platinum 3·6 oz. and osmiridium 7 oz., per ton of concentrate. He also reported : "Palladium was probably present, but the quantity was too small to be definitely identified. The concentrate also contained a large amount of gold."

Zinc Oxide in Australia.—*Chemical Engineering and Mining Review* (Melbourne) for April describes the manufacture of zinc oxide at the plant recently established by the Broken Hill Associated Smelters Proprietary, Ltd., at Port Pirie, South Australia. The French process is employed. The basis of this process is the low boiling point of zinc (about 925°C.), as compared with the boiling points of lead, iron, etc., which usually accompany commercial zinc as impurities. The zinc, being heated in an atmosphere of CO, distils off, leaving those impurities of higher boiling point behind in the retorts, from which they are removed at intervals. Oxide of zinc made by oxidizing the molten metal is a yellow granular product of no use in the arts, whereas the oxide made by oxidizing zinc vapour possesses certain physical properties which render it of great value. The weight of a cubic foot of oxide as collected is about 20 lb. After packing, a cubic foot weighs about 50 lb., while the true weight of the oxide is 350 lb. per cubic foot. Owing to its exceedingly fine state of division it retains entangled air which gives it its light fluffy character. Its extreme whiteness is another of its valuable properties.

The plant consists of a distillation furnace, a gas producer to supply CO gas to the retorts, a retort-annealing stove, a baghouse with fan to collect the oxide, and a re-heating muffle furnace. The distillation furnace, which is hand-fired by means of step grates, carries ten retorts similar to those used in distilling zinc from its ore. The front end of the retort is sealed with a fireclay tile, which is removed when zinc is being charged in, or when dross is being scraped out. Through a hole in this tile CO gas from the producer is introduced. The producer is merely a shallow fire brick shaft with firebars on which the coke fuel is burned. The top is closed and the gas is led off through a pipe to the retorts. At the back end of the retorts there is an opening through which the zinc vapour and the CO gas escape into the combustion chamber. Owing to its high temperature the zinc vapour oxidizes immediately on coming into contact with the air in the combustion chamber, and dense white clouds of zinc oxide rise up and fill the chamber. A newly charged retort shows the lilac blue flame of carbon monoxide. As the temperature rises the flame turns gradually pale green and then bright green as the zinc vapour comes over and burns. Zinc oxide has the property of phosphorescing with a brilliant gold-yellow light when heated to 900°C. or thereabouts, and this temperature is substantially exceeded in the combustion chamber, so that when a retort is in full work the chamber is a most brilliant spectacle. Owing to the very strong light of the burning zinc it is necessary for the furnace attendants to wear cobalt-blue glasses to protect their eyes. The combustion chamber is connected by a flue to the baghouse fan which draws the oxide fume from the chamber and forces it into the collecting bags. The oxide taken from the bags contains an excess of entangled air which renders it too light and bulky to be economically handled. It is therefore re-heating in a muffle furnace, called the re-heating furnace, which expels some of the air and so makes the packing for market a more convenient operation.



ZINC OXIDE PLANT AT PORT PIRIE

SHORT NOTICES.

Rock-Drills.—The *Engineering and Mining Journal* for May 31 gives particulars of the latest pattern of Sullivan air-feed stoping drills.

Efficiency in Drilling and Blasting.—The May *Journal* of the South African Institution of Engineers contains a paper by J. H. P. Bilbrough entitled: "The Increase in the Average Length of a Round in Modern Development." Particulars are given of the time occupied and the methods employed in the Turf section of Village Deep.

Flotation.—In *Chemical and Metallurgical Engineering* for June 1, F. G. Moses discusses a variety of factors in flotation practice, intended for the practical mill-man.

Flotation Oils.—*Chemical and Metallurgical Engineering* for June 1 publishes a paper by L. F. Hawley and O. C. Ralston giving an account of experiments on hardwood tar oils.

Flotation Litigation.—The *Engineering and Mining Journal* for June 14 gives the full text of the United States Supreme Court's decision in the case between Minerals Separation and Butte & Superior.

Mauss Concentrator.—In the *Engineering and Mining Journal* for May 17, E. M. Weston gives an illustrated description of the Mauss centrifugal concentrator, which is used for tin concentration and other purposes in South Africa.

The Lesser Concentrator.—The *South African Mining and Engineering Journal* for May 3 contains a description of a concentrator invented by C. Kumst and financed by the Lesser Ore Reduction Company.

Substitutes for Platinum.—The *Journal of Industrial and Engineering Chemistry* for June contains a paper on palau and rhotanium as substitutes for platinum for laboratory ware. Both of these are alloys of gold and palladium.

Vanadium.—In *Chemical and Metallurgical Engineering* for May 15, J. E. Conley describes a method of extracting vanadium from vanadinite.

Blast-Furnaces.—The *Iron and Coal Trades Review* for June 6 contains a fully illustrated description of iron blast-furnaces recently erected at Park Gate works, Rotherham, and Staveley works, Chesterfield.

Copper Leaching.—In the *Mining and Scientific Press* for May 17, R. W. Perry describes a process for leaching oxidized copper ores with ferric chloride, the patent rights of which are owned by the Midland Ores & Patents Company.

Copper Leaching.—In the *Mining and Scientific Press* for June 7, P. R. Middleton suggests the treatment of copper sulphide flotation concentrates by roasting to sulphate and extracting the copper sulphate by leaching,

Zinc-Retort Residues.—In *Chemical and Metallurgical Engineering* for May 15, K. Stock describes the practice of the Bartlesville Zinc Company in the treatment of zinc-retort residues for the recovery of lead, silver, and gold.

Petroleum in Ecuador.—In the *Engineering and Mining Journal* for May 31, W. M. Brodie gives an account of the geology and occurrence of oil in Ecuador.

Zinc in United States.—In the *Engineering and Mining Journal* for May 31, W. R. Ingalls gives revised figures for the output of zinc in the United States during 1918, with details of the capacities of the various smelters.

Potash in Guatemala.—In the *Engineering and Mining Journal* for June 14, Hoyt S. Gale describes the extraction of potassium nitrate and chloride in various parts of Guatemala.

Colorado Oil-Shales.—In the *Mining and Scientific Press* for May 24, Arthur J. Hoskin writes on oil-shales in Colorado.

Divide, Nevada.—In the *Mining and Scientific Press* for May 10, F. L. Sizer describes the geology and ore deposits of the Divide district, adjacent to Tonopah and Goldfield, Nevada.

Salt Industry of Canada.—The *Canadian Mining Journal* for May 14 reprints a paper by L. Heber Cole on the salt industry and the possibilities for its future development in Canada.

Phosphate in Queensland.—In the *Queensland Government Mining Journal* for March, E. C. Saint-Smith, Government Geologist, describes deposits of rock phosphate on Holbourne Island, off the coast at Bowen.

Ancient Tin Mining in Africa.—The April *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a contribution by E. R. Schoch, manager of the Rooiberg tin mines, to the discussion on Max Baumann's paper on ancient tin mines of the Transvaal.

Heidelberg Goldfields.—The *South African Mining and Engineering Journal* for May 3 contains a description of prospecting work on Modderfontein and Malanskraal farms, south of Heidelberg, along the western part of the Balfour syncline.

Magnetite.—At the June meeting of the Physical Society, E. Wilson and E. F. Herroun read a paper on the magnetic properties of varieties of magnetite.

Protection for Australian Zinc.—The *Industrial Australian and Mining Standard* for April 3 describes the business, present and prospective, of the Electrolytic Zinc Company of Australasia, with particular reference to the necessity for a protective tariff for its various products.

Oxidation of Ammonia.—The *Journal of Industrial and Engineering Chemistry*, the organ of the American Chemical Society, for June, contains an important paper by Charles L. Parsons on the oxidation of ammonia to nitric acid.

Willet G. Miller.—The *Mining and Scientific Press* for June 7 contains an interview with Willet G. Miller, the Provincial Geologist of Ontario.

RECENT PATENTS PUBLISHED.

1,003 of 1917 (126,377). R. E. ALEXANDER, Newcastle-on-Tyne. Improved method of producing coherent metal such as tin from the metal obtained by heating scrap or refuse in a reducing atmosphere.

2,791 of 1917 (126,720). J. P. ROE, London Terminal stations for aerial ropeways of the single cable type.

11,379 of 1917 (118,606). NORTON CO., Worcester, Massachusetts. Method of producing crystalline alumina in the electric furnace.

14,778 of 1917 (127,354). J. W. WHITE, Widnes. Improved means of supporting the carrying ropes used in aerial ropeways

2,255 and 2,256 of 1918 (113,960 and 118,591). NORTON COMPANY, Worcester, Massachusetts. Improvements in aluminous abrasiv

7,008 and 19,333 of 1918 (127,080). J. P. ROE, London. An endless conveyor employing wire rope instead of chains.

7,908 of 1918 (115,647). I. BÖHN, Sörumsanden, Norway. A tunnelling machine having a number of reciprocating drills; no explosives are employed

8,440 of 1918 (127,095). F. W. DAVIS, Magheramorne, Antrim. Method of treating flue gases containing steam, with water, particularly gases coming from cement kilns or from furnaces used in dehydrating aluminium hydroxide.

9,195 of 1918 (127,119). HUNTINGTON, HEBERLEIN & CO., LTD., H. J. BUSH, and H. A. BURNS, London. Improvements in the electrostatic method of precipitating dust from gases, whereby the electric discharge from the electrodes is prevented from becoming concentrated on parts of the electrodes.

9,888 of 1918 (127,128). W. ANDERSON, Helensburgh, Glasgow. Method of recovering cyanides and sulphur from spent oxide used in the purification of coal gas.

10,464 of 1918 (127,134). C. KRAUSE, Luderitzbucht, S.W. Africa. Improvement in jigs used for recovering diamonds.

11,531 of 1918 (118,097). PRATT ENGINEERING & MACHINE CO., Atlanta, Georgia. Improved method of burning sulphur for the production of sulphuric acid.

20,080 of 1918 (121,599). METALS DISINTEGRATING CO., New York. Method of reducing metals to fine powder by treating them in a molten state by means of jets of steam

NEW BOOKS

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

The Efficient Purchase and Utilization of Mine Supplies. By Hubert N. Stronck and John R. Billyard. Cloth, octavo, 97 pages, illustrated. Price 6s. net. New York: John Wiley & Sons; London: Chapman & Hall.

If an analysis of the current mining costs of the world were made, it would probably be found that, roughly, of the total average cost of operation, labour accounted for 60%, supplies for 30, and establishment for 10. In mining, as in manufacturing, the chance of success is increased by the concern being run on business lines. It is therefore important that the department through which flow materials that are accountable for more than a quarter of the running cost should be equipped with an efficient system for controlling the buying, receiving, storing, and issuing of supplies. Of this requirement, most mining engineers are aware; but, usually, being by training technical men first and, by want of training, business men second, they are more attracted by investigations which have for their object the improvement of methods employed in the mine and the mill, than by those which aim at the betterment of the systems followed in the office and the store. Store-keeping is closely allied to banking. It differs from it mainly in that materials instead of cash pass over the counter. To both commodities are equally applicable the business principles that safeguard against misuse. The manager is not niggardly who devotes close attention to devices for eliminating carelessness and waste; and he is not good to his men if he allows them to continue in extravagant ways.

This small book by two American engineers will serve to demonstrate the practical importance attaching to the design of an efficient system of stores purchase and use. It lays stress on schemes for large mines, with simplified methods for smaller ones; and, in recognition of the desirability of introducing modifications to meet particular cases, is suggestive rather than admonitory. It considers the subject in its broader issues under six main heads: Purchasing department; receiving and testing; stores system; issuing systems; reports of consumption of stores; and methods of preventing waste. It develops it in detail under sub-heads: Catalogue files, special quotations, correspondence and general price list, economic amount to be purchased, book of standards, purchase orders, location of store-rooms, arrangement of store-rooms, stock piles, powder magazines, interior arrangement of warehouse, bins, racks, mnemonic classification of materials, stores records, checks, graphic charts, records of equipment, tools, lubricants, timber, pipe-lines, prevention of corrosion, fuel consumption, and training and loyalty of workmen. Twenty-six illustrations of forms suitable for various types of stores records and a plan of a simple style of warehouse are given; and fourteen pages are allotted to an example of a store's mnemonic classification.

The inclusion of a consideration of such matters as the protection of ground pipe-lines from corrosion, fuel consumption in the boiler room, and methods of timber preservation, all of which are primarily the affair of the foreman engineer, interferes with the unity of the subject-matter.

The book is well produced, but possesses no table of contents, list of illustrations, or index; and the price at which it is issued seems high for the amount of information it contains.

ALEX. RICHARDSON.

Traps for Saving Gas at Oil Wells. By W. R. Hamilton. Technical Paper 209 published by the United States Bureau of Mines.

Notes on Lignite, its Characteristics and Utilization. By S. M. Darling. Technical Paper 178 published by the United States Bureau of Mines

Fume and Other Losses in Condensing Quicksilver from Furnace Gases. By L. H. Duschak and C. N. Schuette. Technical Paper 96 published by the United States Bureau of Mines.

Cadmium in 1918. By C. E. Siebenthal. This pamphlet is a chapter of "Mineral Resources 1918," and is published by the United States Geological Survey. It gives particulars of the production and sources of cadmium and of some information as to war uses.

COMPANY REPORTS

British Broken Hill.—This company was formed in 1887 to purchase Blocks 15 and 16 from the Broken Hill Proprietary at Broken Hill, New South Wales. The property has not been one of the most successful of the silver-lead-zinc mines of the district. A new ore-body was discovered in 1912. The mine was closed on the outbreak of war, and operations were resumed in January, 1917. We recently gave particulars of the new flotation plant installed. The report for the half-year ended December 31 last shows that 3,145 tons of carbonate ore was raised, averaging 24·9% lead and 4·7 oz. silver, and that 105,697 tons of sulphide ore was raised, averaging 12·4% lead, 10·8% zinc, and 7·1 oz. silver. The lead mill treated 105,727 tons of sulphide ore, producing 16,679 tons of lead concentrate averaging 61·5% lead, 6·9% zinc, and 27 oz. silver. The flotation plant treated 77,722 tons of tailing averaging 11·5% zinc, 3% lead, and 3·1 oz. silver, for a yield of 13,550 tons of zinc concentrate averaging 44·9% zinc, 8·7% lead, and 10·5 oz. silver. Slime to the amount of 11,326 tons, averaging 5·3% lead, 12% zinc, and 5·1 oz. silver, was stacked for future treatment. The reserve of sulphide ore was estimated on December 31 at 1,095,015 tons averaging 12·8% lead, 11·6% zinc, and 6·7 oz. silver. The accounts show a balance of profit of £39,383. Owing to the zinc concentrate being unsaleable and also to the drop in demand for lead since the Government's contract to purchase expired on March 31, no dividend is being paid. At the time the report was issued, the mine and mill were idle owing to a strike.

Zinc Corporation. — This company operates the South Blocks mine at Broken Hill and treats purchased accumulated zinc tailing. Bewick, Moreing & Co. are the general managers. The report for 1918 shows that 135,580 tons of ore averaging 15·6% lead, 9% zinc, and 3 oz. silver per ton was sent to the lead mill. The products of concentration were 28,351 tons of lead concentrate averaging 64·4% lead, 7% zinc, and 10·5 oz. silver, together with 45,133 tons of zinc middling averaging 16·4% zinc, 4·4% lead, and 1·9 oz. silver. At the flotation plant 257,300 tons of zinc tailing and slime was treated, averaging 14·3% zinc, 5·1% lead, and 6·2 oz. silver. The yield of zinc concentrate was 61,470 tons averaging 47·5% zinc, 7·6% lead, and 10·8 oz. silver; of lead concentrate 5,230 tons averaging 57·6% lead, 14·8% zinc, and 28·9 oz. silver; and of zinc slime 9,080 tons averaging 36·6% zinc, 15% lead, and 23·3 oz. silver. The last-named was stacked for future treatment. The sale of concentrates brought an income of £742,693, and the profit was £226,470, out of which £39,000 was placed to mine development account, and £10,000 to new plant account. The dividends absorbed £183,963, being at the rate of 32½% on the £245,692 preference shares and 30% on the £329,308 ordinary shares. The mine continued to develop well during the year. On December 31 the reserve was estimated at 2,076,000 tons averaging 14·6% lead, 9·4% zinc, and 2·6 oz. silver, being an increase of 189,000 tons during the year. There remains on the old dumps 763,978 tons of zinc tailing awaiting treatment.

Amalgamated Zinc (De Bavay's).—This company was formed in 1909 to treat zinc tailing from the North and South mines at Broken Hill by the De Bavay flotation process. The contract with the North mine expired on April 30, and that with the South mine will expire at the end of this year. A contract was recently made with the Junction mine, but, as the deliveries were not satisfactory, notice has been given of suspension of the contract. The plant hitherto used on North tailing is to be employed for the treatment of dump material purchased some time ago. The company owns a large interest in the Electrolytic Zinc Co. of Australasia. The report for the half-year ended December 31 last shows that 112,775 tons of tailing was treated, for a yield of 30,038 tons of zinc concentrate averaging 47·4% zinc, 7% lead, and 9·3 oz. silver, together with 1,807 tons of lead concentrate averaging 54·2% lead, 11·9% zinc, and 61·3 oz. silver. The accounts show a profit of £32,913, of which £8,604 was applied to reserve for depreciation, and £25,000 was distributed as dividend, being 1s. per £1 share.

Mount Boppy Gold.—This company was formed by John Taylor & Sons in 1899 to acquire a gold mine in Cobar district, New South Wales. Mining operations were uniformly successful from 1902 to 1911. After the latter year several factors militated against success. Finally it was decided to sink a new shaft 400 ft. deep in the country rock so as to work the ore round the main shaft. The report for 1918 shows that the shaft was completed by the beginning of that year and that milling was resumed in February. Owing to entire absence of rain, the water supply was exhausted in November, and work had to be suspended. During the ten months, 61,176 tons of ore was milled, for a yield of 8,554 oz. of gold bullion. In addition, 13,152 oz. was extracted by cyanide, and 859 oz. from concentrate and slag, bringing the total yield to 22,665 oz., containing 15,577 oz. of fine gold worth £65,551. The working cost was £71,508. Rain fell in March, and operations were resumed for a short time. Developments, though restricted, have been fairly promising, and the reserve on December 31 was estimated at 188,158 tons. There is also a large amount of oxidized ore that can be worked cheaply by open-cut. It is intended to reconstruct the company in order to provide further funds for development.

Great Boulder Proprietary.—The twenty-fifth annual report of the premier gold-mining company operating at Kalgoorlie, West Australia, covering the year 1918, shows that 152,196 long tons of ore was treated, yielding £154,316 by amalgamation and £323,982 by cyaniding. In addition, 19,801 tons of old tailing yielded £5,917, making the total output of gold £484,210. The net profit was £220,931, out of which £19,577 was allowed for Australian taxation, and £196,875 was distributed as dividend, being at the rate of 2s. 3d. per 2s. share. The total cost per long ton was 32s. 6d., as compared with 28s. 8d. in 1917. Little development has been done during the year, and the expectation of any considerable additional ore being found is not great. The reserve at December 31 was estimated at 345,719 tons averaging 14·49 dwt. per ton, as compared with 387,571 tons of similar tenor the year before. Since the beginning of operations the total gold output has been £11,649,970. From 1900 to 1918, the average output was about £550,000.

Oroya Links.—This company was formed in 1896 as the Golden Link, and has been twice reconstructed. The name was changed in 1909 when property and plant were bought from the Oroya Brownhill. Small dividends were paid from 1910 to 1914. Owing to war conditions, operations were suspended in 1916, and portions of the mine were let on tribute. Bewick, Moreing & Co. are the general managers. The report for 1918 shows that 16,181 tons of ore was raised by the tributers, of which 12,403 tons was treated at the company's mill, and 3,778 tons at other mills. The 12,403 tons, together with 6,498 tons purchased, yielded gold worth £100,582. The royalty accruing to the company was £18,358, and the company's net profit was £5,439, of which £3,000 was written off development and shaft-sinking account.

Waihi Grand Junction.—This company was formed in 1897 to work extensions of the lodes of the Waihi company, in the northern island of New Zealand. The report for 1918 shows that 80,210 tons of ore was treated, yielding gold and silver worth £141,755, equal to 35s. 2d. per ton. Owing to shortage of labour and to the influenza epidemic, the tonnage was much below normal, comparing with 116,130 tons the year before The grade of the ore also shows a decrease, the yield per ton comparing with 39s. 9d. in 1917. During the first four months of the current year, the yield has further decreased to 30s. per ton. The working cost for the year under review was £140,034, leaving a profit of £5,616. The company has had, however, to provide £15,000 for income tax in London and New Zealand, so that the balance for the year is on the wrong side. Owing to labour shortage, it has not been possible to maintain development, and only 3,145 ft was done, as compared with 4,692 ft. in 1917. The reserve is estimated at 106,400 tons, being a decrease of 25,200 during the year.

Lahat Mines.—This company belongs to the Tronoh group, and was formed in 1906 to acquire a tin-gravel property at Lahat, in the Kinta valley, Perak, Federated Malay States. Four years ago Osborne & Chappel were appointed managers. The report for 1918 shows that 397 tons of tin concentrate was produced, as compared with 452 tons the year before. The fall is due to shortage of labour, the smaller working area with depth, and the fall of ground on the west side of the mine. Tin sales brought an income of £74,090, and the net profit was £29,848, out of which £27,000 was distributed as dividend, being at the rate of 22½%. Additional ground has recently been acquired, chiefly to serve as a dump for tailing, but about 100 acres of it is workable for tin.

Idris Hydraulic Tin.—This company belongs to the Tronoh group, and was formed in 1913 to work alluvial tin properties in Perak, Federated Malay States. The report for 1918 shows that 102 tons of tin concentrate was produced from the Batu Karang section, and 22 tons from the Kranji section. As the workings in the former section became too deep, and the seepage began to be dangerous, the working was abandoned. Meanwhile a new paddock was opened, and the gravel pumps transferred. The Kranji section was transferred in the middle of the year to the owners of adjoining properties, who are now working the deposit on a profit-sharing basis. The Snudong property has been let on tribute. The company's total output of tin concentrate was 124 tons as compared with 213 tons in 1917. The income from sales was £21,513, and the expenditure £20,951. After allowance for taxes and depreciation, a net loss of £3,073 was incurred. W R. H. Chappel, one of the managers, is on his way to the mines to investigate conditions and prospects.

Sungei Besi.—This company belongs to the Tronoh group, and was formed in 1909 to work alluvial tin ground in the State of Selangor, Federated Malay States. The report for 1918 shows that the output of tin concentrate was 402 tons as compared with 40[illegible] tons the year before. The receipts from sales were [illegible], and the net profit was £30,304, out of which £11,140 has been distributed as dividend, being at the rate of [illegible]. As the company is liable for Excess Profits Duty this year, the balance is carried forward. During the year, the electrical power station has been moved, and the ground on which it stood is thus made available for treatment. Negotiations are in hand for additional property adjoining on the north.

Tronoh South.—This company belongs to the Tronoh group, and was formed in 1911 to work alluvial tin property in Perak, Federated Malay States. The report for 1918 shows that operations were suspended in August owing to poor results, and tributers who took the workings soon abandoned them. The company's output was 106 tons of tin concentrate, and the tributers extracted 12 tons. The profit for the year was £6,011, and £2,500 was distributed as dividend, being at the rate of 2½%. The directors are looking for other properties. The company owns ground that can be treated by bucket-dredge, and is estimated to contain 1,785 tons of black tin. It has not yet been decided how to deal with this area.

Mongu (Nigeria) Tin Mines.—This company was formed in 1914 to acquire from the Anglo-Continental Mines Co. alluvial tin property in the Ropp district, Nigeria. W. F. Turner is the chairman, and Lewis Rumbold & Co. are the consulting engineers. The report for 1918 shows that the output of tin concentrate was 476 tons, of which 299 tons was obtained by sluicing and 177 tons by dredging. The output was 95 tons lower than in 1917, owing partly to scarcity of labour, and partly to low-grade areas being worked during the period of high prices of tin. The accounts show a profit of £59,788, out of which £28,788 has been distributed, being at the rate of 25%, less income tax. About £30,000 is reserved for Excess Profits Duty. During the year, nine new mining rights were acquired, covering a length of over eight miles on tributaries of the Mongu river.

Naraguta Extended.—This company was formed in 1911 to acquire, from the Anglo-Continental Mines Co., alluvial tin property on the Delemi River, Nigeria. S. R. Bastard is chairman, C. G. Lush & Son are consulting engineers in London, and R. W. Hannam is consulting engineer in Nigeria. The report for 1918 shows that the output of tin concentrate was 280 tons, as compared with 334 tons in 1917. Of the output, 154½ tons was won by the company and 125½ tons by tributers. The amount won by tributers tends to decrease gradually. The reason why the company's output was less than in 1917 was partly the influenza epidemic, and partly the necessity for working low-grade areas left behind when selective mining was the policy. With new plant now in course of erection, it will be possible in future to work all the ground as it comes. The profit for the year was £16,074, out of which £13,[illegible]05 has been distributed as dividends, being at the rate of 12½%, less income tax.

Ex-Lands Nigeria.—This company was formed by the Exploring Land & Minerals Co., in 1912, to acquire alluvial tin property in the South Bukeru district, Nigeria. In 1914 additional property was purchased from the Budurua company. The report for 1918 shows that the output of tin concentrate was 34[illegible] tons. Owing to scarcity of labour and the influenza epidemic the output was lower than that of the previous two years. The net profit for the year was £35,221, out of which £16,862 has been distributed as dividend, being at the rate of 12½%, free of income tax. A large sum has to be reserved for excess profits tax.

Bisichi Tin.—This company was formed in 1910 to acquire alluvial tin ground in Nigeria. James Gardiner is chairman and A. W. Hooke is manager. Hydraulicking commenced in April, 1912. The report for 1918 shows that owing to scarcity of labour during the latter part of the year, due to the influenza epidemic, the plant was not operated to its full capacity. The output was 275 tons of tin concentrate, and the net profit was [illegible]. The dividends absorbed £25,000, being at the rate of 12½%.

Lower Bisichi (Nigeria) Tin Mines.—This company belongs to the Tin Areas group, and was formed in 1912 to acquire alluvial tin property in Nigeria. The report for the year ended September 30 last shows that 57½ tons of tin concentrate was extracted, as compared with 64 tons the year before. The net profit was £5,014, out of which £2,552 has been paid as dividend, being at the rate of 12½%, while £1,000 has been placed to reserve and £500 written off development account.

Oroville Dredging.—This company was formed by F. W. Baker in 1909 to acquire the share capital of an American company of similar name operating gold dredges on Feather River, near Sacramento, California. Subsequently subsidiaries called the Pato and Nechi were formed to undertake similar work in Colombia. The report of the American Oroville company for the year ended September 30, 1918, shows that the California property is nearing exhaustion and that only one dredge was at work. The yardage treated was 2,433,161 cu. yd., and the yield of gold $95,472, or 3·92 cents per yard. The net loss for the year was $1[illegible]. Dividends from previous balances absorbed $355,018, of which £71,993 was received by the English Oroville company, which distributed £68,653, being at the rate of 10%.—**Pato Mines (Colombia).** The report for the year ended September 30 shows that 1,345,215 cu. yd. was treated for a yield of gold worth $[illegible], as compared with 1,181,945 cu. yd. and $650,522 the year before. The yield per yard was [illegible] cents, as compared with 55 cents. The yield in English money was £54,745 and the net profit was £12,832. The outstanding income notes representing capital advanced by Oroville Dredging have been paid off.—**Nechi Mines (Colombia).** The report for the year ended September 30 shows that the dredge treated 1,076,558 cu. yd. for a yield of $253,787, or 23·57 cents per yard, and also treated 1,066,371 cu. yd. of Pato ground for a yield of $183,711, or 17·2 cents per yard. The net profit was £25,841. The preference and ordinary shares received dividends of 25%, absorbing £35,000, being £17,500 to each class of share.

Esperanza.—This company was formed in 1903 by F. W. Baker and others, to acquire the bulk of the shares of an American company of similar name operating a gold mine at El Oro, Mexico. The mine is now nearing exhaustion. The report for 1918 shows 181,832 dry metric tons of ore and old fillings was treated for a yield worth £336,000. The working profit of the American company was £40,555, but, as £48,761 was placed to reserve for depletion of ore and depreciation in order to avoid American income tax and excess profits duty, a loss for the year of £8,206 was incurred. The American company paid dividends of $135,000 out of the balance brought forward from 1917, and the English company has paid £16,209, being at the rate of 1s. per share, less income tax. The reserve of ore blocked out was estimated on January 1 at 35,131 tons, and the old fillings at between 50,000 and 100,000 tons. It is expected that, in addition, fairly large amounts of ore will be disclosed in extracting the fillings. As already announced, the company has recently taken an option on property situated on the west coast of Mexico.

St. John del Rey.—This company was formed in 1828 to work the Morro Velho gold mine in Minas Geraes, Brazil. For over thirty years it has been in the charge of George Chalmers. The report for the year ended February 28 last shows that 165,000 long tons of ore was milled, for an extraction in gold worth £423,029, and silver worth £6,040. The yield per ton was 52s. Of the gold, 37s. 7d. came from concentrates and 13s. 5d. by cyaniding tailing. The working cost was £290,876, and State and other charges were £13,855, leaving a working profit of £124,338. Out of this, £35,000 was placed to capital expenditure account. Dividends of 10% were paid on £100,000 preference shares and £546,265 ordinary shares. Owing to severe floods and the influenza epidemic, the ore milled was 15,300 less than the year before, and the profit £29,341 less, but the amount distributed was the same. Owing to war conditions, it has been impossible to proceed with the scheme for cooling and ventilating at depth. The deepest working is now Horizon 21, at 6,126 ft. vertically below outcrop. The ore-body here is as satisfactory both as to extent and assay-value as in the levels above. The reserve is estimated at 1,209,104 tons, sufficient to last 6½ years at the normal capacity, 192,000 tons per year.

Ouro Preto Gold Mines of Brazil.—This company was formed in 1884 by John Taylor & Sons to work the Passagem gold mines in the State of Minas Geraes, Brazil, in the same district as the mines of the St. John del Rey company. Several reconstructions have been necessary, and the dividends have been few. The ore is not so persistent or of so high a grade as that at St. John del Rey. The report for 1918 shows that 63,400 tons of ore was raised and treated, yielding 21,245 oz. of gold, realizing £90,234, or 28s. 6d. per ton. The profit for the year was £1,222. During the previous year, 82,500 tons was treated. The decrease was due to shortage of labour and to the influenza epidemic. Developments have given good results in the 920 and 1,040 metre levels south-west of Secondary No. 2 shaft. The reserve is estimated at 81,874 tons, an increase of 20,644 tons during the year. Furnaces for recovering arsenic have recently been despatched, and for the purpose of providing the cost, £10,000 debentures were issued in April.

Rezende Mines.—This company was formed in 1892, as the United Goldfields of Manica, to work gold mines in the Umtali district of Rhodesia. There have been three reconstructions, and in 1912 the mine and plant of the Penhalonga company were acquired. The Penhalonga mine was, however, exhausted two years later. Two years ago the control passed to Sir Abe Bailey, and the head office was moved from London to Rhodesia. At about that time, ore of much higher grade was discovered. The report for 1918 shows that 23,293 tons was raised from the Central section and 31,177 tons from the Eastern section. At the mill, 54,000 tons of ore was treated, averaging 13·76 dwt. per ton. The total yield of gold by amalgamation, cyaniding, and from concentrate was 35,516 oz. Of the gold produced, £129,279 was credited to revenue account, and the remainder placed to bullion reserve. The working profit was £48,557, and the net profit £41,561, out of which £23,687 has been distributed as dividend, being at the rate of 20%. The ore reserves have continued to increase, and now stand at 175,374 tons averaging 12·66 dwt., as compared with 135,941 tons averaging 11·77 dwt. a year ago. Of the total, 60,748 tons averaging 7·05 dwt. is in the Central section, and 114,626 tons averaging 15·63 dwt. is in the Eastern section. These are the figures given by the consulting engineer and the manager; the directors, in their report, give the figures at 447,690 tons. Development is being continued actively in promising ground.

Village Main Reef.—This company was formed in London in 1890 by the Consolidated Gold Fields to acquire from a South African company a mine in the central Rand below the Salisbury, Jubilee, and the western part of the City & Suburban. The remains of the Wemmer outcrop property were acquired later. During recent years the technical control has been with Rand Mines, Limited. The report for 1918 shows that 279,264 tons of ore was raised, and after the rejection of waste, 265,585 tons averaging 7·22 dwt. per ton was sent to the mill. The yield by amalgamation was 67,333 oz., and by cyanide 25,929 oz., making a total of 93,252 oz., worth £388,504, or 29s. 2d. per ton milled. The working cost was £299,073, or 22s. [illegible]d. per ton, leaving a working profit of £89,431, or [illegible]s. [illegible]d. per ton. The shareholders received £47,200, being at the rate of 22½%, which will be distributed in the form of shares in Village Deep. The ore reserve is estimated at 378,510 tons averaging 7 dwt., a reduction of 249,640 tons during the year. The development is now nearly complete, and future operations will depend more and more on reclamation. Severe falls of ground have made it almost impossible to stope the richer ore in the deeper levels.

Ferreira Deep.—This company belongs to the Rand Mines group, and was formed in 1894 to acquire property on the dip of the Ferreira in the central Rand. Production commenced after the Boer war, and excellent dividends have been paid since 1904. The mine has suffered much from crushing and collapses of the hanging wall. To obviate these dangers the system of reef-packing was introduced. The report for 1918 shows that 556,330 tons of ore was raised, and after the rejection of waste, 508,350 tons, averaging 7·95 dwt., was sent to the mill. The yield by amalgamation was 143,585 oz., and by cyanide 49,649 oz., making a total of 193,234 oz., worth £806,694, or 31s. 9d. per ton milled. The working cost was £594,978, or 33s. 5d. per ton, leaving a working profit of £211,715, or 8s. 4d. per ton. The dividends absorbed £220,500, or 22½%. Development of the best ground is nearly complete, and only 143,700 tons averaging 6·6 dwt., was added to the reserve during the year. The reserve now stands at 932,400 tons averaging 8 dwt., of which 375,800 tons is not immediately available, being in pillars and isolated blocks. There is also 307,660 tons in the reef-packs. An area in the eastern part of the mine, believed to be of low grade, remains to be developed.

Geldenhuis Deep.—This company was formed in 1893 to acquire deep levels in the near east Rand, below the Geldenhuis Estate. The control is with Rand Mines, Ltd. The report for 1918 shows that the output continues to decrease. The ore raised was 655,968 tons, and after the rejection of waste, 591,100 tons averaging 5·8 dwt. was sent to the mill. The yield of gold by amalgamation and cyaniding was 164,476 oz., worth £684,688, or 23s. 2d. per ton milled. The working cost was £683,480, or 23s. 1d. per ton. The year before, 648,000 tons milled yielded £772,255 at a cost of £675,551. The ore reserve is estimated at 1,549,600 tons averaging 5·9 dwt., as compared with 1,811,000 tons averaging 5·8 dwt. a year ago. The development of the eastern section of the property is nearly complete. A fairly large area remains to be developed in the western section, but the tonnage of payable ore that can be expected is not great, and the cost of development will be considerable.

Durban-Roodepoort Deep.—This company was formed in 1895 to acquire deep-level ground in the Roodepoort district of the western Rand. The control is with Rand Mines, Ltd. The profits have never been great, and three years ago the output began to decrease slightly. The report for 1918 shows that 359,626 tons was raised, and after the rejection of waste, 300,450 tons averaging 7·52 dwt. per ton was sent to the mill. The yield by amalgamation was 74,596 oz., and by cyanide 33,687 oz., making a total of 108,263 oz., worth £450,344, or 30s. per ton milled. The working cost was £420,277, or 28s. per ton, leaving a working profit of £30,067, or 2s. per ton. The shareholders received £11,000, being at the rate of 2½%. The reserve is estimated at 1,078,500 tons averaging 6·5 dwt. The deeper levels are to be developed by a new vertical shaft, the sinking of which was commenced at the end of February of this year.

Roodepoort United Main Reef.—This company belongs to the Albu group, and owns outcrop and deep-level properties in the west Rand. It was formed in 1887, and there have been several rearrangements and amalgamations. Dividends were paid from 1894 to 1910, except during the Boer war. In 1910, funds were borrowed from the General Mining & Finance Corporation to push developments and erect a modern mill. These loans are still outstanding. The report for 1918 shows that 291,878 tons was raised, and 286,313 tons averaging 5·14 dwt. per ton was sent to the mill. The yield by amalgamation and cyanide was 69,652 oz., worth £290,792, and the working cost was £324,968. The ore reserve is estimated at 223,041 tons averaging 6·02 dwt. Owing to the increase in cost, it has been necessary to eliminate large blocks from the reserve. Recourse is now being had to low-grade reclamation ore, which can be mined comparatively cheaply.

West Rand Consolidated.—This company belongs to the Albu group, and was formed in 1903 to acquire a number of properties in the far west Rand. In 1907 the Violet mine and mill were bought, and in 1915 part of the property of the Lancaster West was purchased. The property includes workings on the Botha, or Main, Reef, and on the Battery Reef to the south. Milling started in 1908. The only dividend paid was one of 3¾% in 1909. The issued capital is £2,004,424, and there are £223,221 debentures. The report for 1918 shows that 258,727 tons was raised from the Botha Reef and 126,384 tons from the Battery Reef, and after the rejection of waste, 379,530 tons averaging 5·46 dwt. per ton was sent to the mill. The yield of gold by amalgamation and cyaniding was 96,575 oz., worth £403,195, and the working cost was £410,743. The ore reserve is estimated at 1,208,315 tons averaging 6·1 dwt. The feature of the year's development was the discovery of high-grade ore in the Battery Reef between the 6th and 9th levels.

Aurora West United.—This company was formed in 1889 to acquire property on the outcrop in the middle west Rand. There were several reorganizations and absorptions in the early days, and milling was not continuous. Operations were resumed in 1908. Further reconstructions took place in 1909 and 1912, and in addition, capital has been borrowed from the Albu parent company, the General Mining & Finance. The report for 1918 shows that 173,663 tons was raised, and after the rejection of waste, 158,550 tons was sent to the mill. The yield of gold was £178,462, or 22s. 6d. per ton, and the working cost was £177,067, or 22s. 4d. per ton. The ore reserve is estimated at 242,[illegible]08 tons, averaging 5·6 dwt. Owing to increased cost, it has been necessary to omit large amounts of South Reef from the reserve. Delays in obtaining the necessary pumps have postponed the development of the 1[illegible]th level.

New Goch.—This company belongs to the Albu group, and was formed in 1887, as the George Goch, to acquire claims on the outcrop in the central Rand between Wolhuter and Nourse. There have been several reconstructions and rearrangements of capital and property. Dividends were paid for 1910, 1911, 1915, 1916, and 1917, and in 1915 the outstanding debentures, £112,475, were redeemed. The report for 1918 shows that 199,070 tons of ore was raised, and 197,300 tons averaging 4·36 dwt. per ton was sent to the mill. The yield by amalgamation and cyaniding was 39,436 oz. In addition, 34,200 tons of accumulated slime yielded 3,595 oz. The total revenue was £185,655, and the expenditure was £186,283. The ore reserve is estimated at 111,670 tons averaging 5·6 dwt. There is a fairly large amount of partly developed ore, and much of this may be worth working, though no definite estimate of its value can be made. Reclamation ore will also help to keep the mill going.

Glencairn.—This company belongs to the Barnato group, and was formed in 1889 to acquire property on the outcrop in the middle east Rand. As already recorded the mine is exhausted and hoisting ceased last November. The report for 1918 shows that 218,786 tons of ore was raised, and after the rejection of 8% waste, 200,900 tons averaging 3·5 dwt. was sent to the mill. The yield by amalgamation was 20,443 oz., and by cyaniding 10,519 oz., making a total of 30,962 oz., worth £132,152. In addition, £5,029 was obtained from 16,868 tons of accumulated slime, and £5,407 from clean-up of the mill. The net profit was £6,796, which with the balance £20,838 brought forward from the previous year, made a disposable balance of £27,634. Out of this, £27,500 has been distributed as dividend, being at the rate of 5%. Operations are now confined to the treatment of accumulated slime, of which there remains about 190,000 tons averaging 2 dwt. The rate of treatment will be 7,500 tons per month.

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.Sc., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill*, both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION: U.K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.)

Vol. XXI. No. 2. LONDON, AUGUST, 1919. PRICE ONE SHILLING

CONTENTS.

EDITORIAL

ATTENTION is once more being drawn to the advantages offered by tin as a material for out-of-door memorials. In the permanence of its surface it is not rivalled by any other metal than gold. The tablet in the Chelsea Physic Garden to the memory of Sir Hans Sloane is an excellent example of the superiority of tin over bronze or stone.

THAT active body, the British Lead & Zinc Miners' Association, had a convincing spokesman in Professor Henry Louis, when they appeared before the Royal Commission on the Income Tax. He urged that mines should be allowed to redeem their capital without taxation, and that the cost of all development and renewals of plant should be deducted before assessing profits. We hope that other public bodies interested in non-ferrous metal mining will offer similar testimony.

THE Government has at last granted the South African gold producers the concession of permission to dispose of their output in the most favourable market. It is now possible to sell the gold in the United States, where the producers will at present have an advantage in exchange to the extent of nearly 10%. Hitherto this profit has accrued to the British Government. The benefit to the producers will, of course, be a variable factor, depending on the balance of English debts to America, and in times of British prosperity the concession will be meaningless.

OIL magnates in America are becoming alarmed at the gradual increase of British control of the oilfields of the world. In the United States the influence of the Shell combine is regarded with some anxiety, and in Western Canada strenuous opposition has even arisen. The acquirement by English shipping interests of the control of the Huasteca Petroleum Co., the company formed some years ago by the brothers Doheny to operate south of Tampico, is another event of importance. The purchase of the Scottish oil-shale properties by the Anglo-Persian company, the activities in connection with oil-drilling in the Midlands and elsewhere, and the development of the Norfolk oil shales, are helping to focus the attention of the public on the importance of oil. The Admiralty and certain sections of the mercantile marine are backing oil, a fact which explains their comparative indifference in the matter of the coal strike.

ELSEWHERE in this issue we publish a rejoinder to our remarks last month on the Spitsbergen iron ore enterprise. This letter is written by Mr. Ernest Mansfield, a prospector who has been in the islands for some years in the service of the Northern Exploration Company. His contribution to the discussion deals chiefly with the international rivalry for the possession of the islands and their minerals, and does not give any specific information with regard to the question we raised, namely, the value and extent of the iron ore deposits. It is announced that Mr. William Selkirk has left for Spitsbergen for the purpose of examining these deposits. Until his report is published, it is little use arguing the matter further.

IN another part of this issue a full abstract is given of the patents describing Mr. F. E. Elmore's new process for separating lead and zinc sulphides. As mentioned last month, the essential idea is to convert lead sulphide into lead sulphate by treatment with hot concentrated sulphuric acid, the zinc sulphide remaining unattacked, and to dissolve the lead sulphate in a solution of brine. This attack of finely ground galena by sulphuric acid is a reaction unknown to the text-books. It is interesting to note that the patentee and his friends do not intend to rely for their profits on royalties, but will work the process themselves. Many properties can be obtained where the process is applicable, and ore and concentrates can also be treated at the works in this country. Arrangements have already been made for the sale of the foreign and colonial patents. The Chemical & Metallurgical Corporation, which controls the patents, is not confining its attention to this one particular process, but is open to finance other inventions. For instance, the François cementation patents have been acquired, and a number of contracts for sealing-off underground water have been taken over.

THE committee of the Royal School of Mines Old Students' Association has had no small difficulty in preparing the Register of Old Students. In January of last year we referred to this subject at some length, and appealed to all readers who have been at the Royal School of Mines to forward the particulars of their record for inclusion in the Register. At the time, only about 500 out of over 2,000 had responded to the circular appeals of the committee. Subsequently the number of records secured reached about 600. It was felt that no further delay was permissible in printing the Register, but before finally proceeding with the binding it was decided to circulate it in proof form among all who had sent their records. Old students and others who see the proofs may observe the absence of names they know, and in this way laggards and absentees will be afforded another chance of being included. When the Register is finally complete it will be bound with the History of the Royal School of Mines, written by Miss Reeks, and the volume will include a Roll of Honour, and lists of associates, prizemen, and medallists. In reading the proofs of the entries concerning them, we advise old students to correct errors of typography, of which there are many, due no doubt to illegible hand-writing; and we would also recommend the elimination, in one or two cases, of certain details relating to qualifications which are entirely out of place in a register of this character.

THREE months ago we gave our opinions on the subject of simplified spelling, and our reasons for refusing to depart from the standard of the Oxford Dictionary. Among many letters commenting on the article, a particularly interesting one came from Mrs. Edwin Field, who draws our attention to the Pitman-Ellis phonetic alphabet. This alphabet was invented by Isaac Pitman in 1847, and supported by Alexander J. Ellis, a noted philologist and a Fellow of the Royal Society. It consisted of 40 letters, representing 40 sounds, and in this way presented the only logical form of improved spelling to which we referred in the article. No difficulty is presented in reading words spelt on this system, for there are no doubtful conventions for the pronunciation of the letters of the current alphabet, as is the case with the spelling advocated by the Simplified Spelling Society. The Pitman-Ellis system was received with great interest in the middle of the last century, but it eventually failed owing to one of the drawbacks mentioned by us, namely, the inability of the advocates of simplified spelling to agree as to the exact form and methods. In this case Mr. Pitman was continually suggesting or introducing improvements or alterations, much to the annoyance of his co-operators. The consequence was that the literati and the general public were mystified and became tired, and the propaganda languished. This was a pity, for the system is the only one worthy of serious thought. It is to be hoped that Mrs. Field will be able to resuscitate public interest in the system. Our own view is that the English Simplified Spelling Society and the various organizations for reform in America should join hands, throw over their jejune propaganda, and initiate a campaign on behalf of the Pitman-Ellis system.

DURING the last two or three years, Mr. W. E. Bleloch has been much to the fore in connection with the Far East Rand and the extensions of the goldfields around and south of Heidelberg. Mr. Bleloch is not by any means a novice in Far East Rand geology, as many of our readers will remember, but owing to his being a free lance, his views and activities have not been so well known in this country as locally. He is indeed looked upon by most of the big houses as an interloper, and some people go so far as to say that he has no business to enunciate theories at all. The testing of his theories, however, will make nobody any poorer, and may possibly be to the benefit of the South African community, so it is not for us to throw discouragement in his path. A lengthy series of articles that has lately appeared in the *South African Mining and Engineering Journal* has given us the opportunity to publish some account of his views. These articles are discursive and disconnected, and do not give a very intelligible account of the Bleloch theory, or of the history of the operations on which it is founded. We were obliged to resort to liberal excision and some rearrangement, but the account is still too long and not as clear as we could wish.

LABOUR troubles in the coalfields continue to prevent the resumption of the industries of this country on a peace basis. But disaffection is not confined to the miners, for transport workers, policemen, bakers, and others receiving fixed wages are out of temper with the profiteer, and with everything in general. Economists are once more trying to teach the worker that if wages are increased the price of commodities will be put up by the shops for the sole reason that the customers have more money to spend. But would it not be better for the economists to recommend the mine-owners and other employers to establish trading establishments that would not take advantage of the worker, according to the plan adopted in many other countries? The argument with regard to the vicious circle does not start from the right point, for the high prices of commodities came from scarcity of supplies, and the high wages received in certain quarters originated from extravagant Government offers. Then, again, it is little use telling the toiler that the country is going to ruin unless he works harder and ceases to demand higher wages, while at the same time the roads are crowded with gorgeous motor-cars, the pleasure resorts are full of gay and thoughtless holiday-makers, and the newspapers are filled with descriptions of the magnificent dresses worn by the ladies at Goodwood races and the King's garden parties. It was not over-wise on the part of those in authority to give the children an extra week's summer holiday in commemoration of peace. Another cause of the present love of idleness is to be found in the influence of trench warfare: hour after hour and day after day nothing to do but to grin and bear it. That was not a good preparation for a hustling peace campaign of industry. The country wants a leader who has a different solution to offer than the creation of new Government departments, or suppression of the dukes, or even a promised prosecution of profiteers. In the meantime public expenditure continues at an appalling level, without check or control. The labour unrest is not confined to this country, for in the United States also the high cost of living is causing serious trouble, and agitation has arisen for the placing of the control of certain enterprises such as the railways more in the hands of the Government and the workers. As far as the industries in which this Magazine is interested, the present position is that the non-ferrous metal mining of this country is hard hit by the scarcity of coal and its high price, and that the makers of machinery depending on the regular supply of iron, steel, and coal are unable to promise definite prices or time of delivery for any contracts offered.

Minerals Separation's Future.

Some doubt has arisen in various quarters as to the exact value to Minerals Separation of the recent decision of the United States Supreme Court in connection with the less-than-1% flotation patent. It is pointed out that this patent, No. 835,120, applied for on May 29, 1905, and granted on November 6, 1906, will expire in 1923, so that the company has only four years more of monopoly. This question has to be considered from two points of view, one relating to the collection of past royalties, and the other the value of other patents more recent than that on which the litigation centred. In the first place, the Butte & Superior Company, which was the defendant in this case, will have to pay Minerals Separation between fifteen and twenty million dollars. This is the assessment of the Montana court, published on July 19, and it is based on a far higher rate of royalty than would have satisfied Minerals Separation had the negotiations come to a happy issue at the beginning. Whether Butte & Superior can or will pay the whole amount, or whether it will appeal or adopt some legal subterfuge for evading payment, it is not possible to say, but, as we said in a recent issue in connection with certain unsatisfactory features of American Patent Law, there is many a slip between the awarding of damages and their collection. Presumably other users of flotation methods are rendered liable to similar action and will have to settle their debts, but on this point we have no definite information. The judgment apparently does not cover the Miami case, where agitation is obtained by upward streams of bubbles of compressed air which enter the cells through perforated bottoms, or the employment of other means of agitation than the rapidly rotating impeller. The judges in the Butte & Superior case were only informed of the Minerals Separation method of producing a froth, and as they had no other source of information and were not conversant with general practice, their definitions of the limits of application in their judgments have not been perfectly clear. It is a pity the Miami case did not go to the Supreme Court so that the full effect of the less-than-1% judgment could be ascertained. The judgment of the Appeal Court was not unanimous as to the invalidity of other methods of agitation, and for that reason a final judgment would have been welcome. The Miami company, however, stated some time ago that it did not intend to appeal to the Supreme Court. At the present time, therefore, the legality of other methods of agitation in connection with the use of less than 1% of oil is not satisfactorily settled.

When the future of Minerals Separation is considered, it has to be remembered that the process is not based merely on this particular patent. The company has had for years a staff of investigators who have introduced many improvements. An echo of one of these improvements is to be found in the recent Supreme Court's judgment, where it was incidentally laid down that the use of pine oil constituted a vast advance in practice. The original statement to this effect is found in the judgment of the Court of Appeal in the Miami case. On that occasion it was held that patents 962,678 of 1910 and 1,099,699 of 1914 were valid. As the suit was not carried to the Supreme Court this judgment stands, at any rate for the present. The first of these patents was granted to Sulman, Greenway, and Higgins, and covers the use of organic compounds miscible in water obtained by the distillation of coal and wood. It is thus clear that the use of soluble frothing agents such as pine oil and coal tar compounds is under the control of Minerals Separation. The other patent, in Greenway's name, covers the use in connection with copper ores of aromatic hydroxy compounds such as phenol and cresol in a cold solution without acid. These two patents are good until 1927 and 1931 respectively. So it will be seen that Minerals Separation has other strings to its bow than the original patent that disclosed the secret of the commercial success of flotation.

While writing of flotation, it is convenient to draw attention to the revival in the American press of an old claim on the part of Mr. J. D. Wolf in connection with rapid agitation as applied to flotation. Mr. Wolf took out patents in 1903, numbered 4,793 in Great Britain and 787,814 in the United States. In the course of his process he used a rapidly rotating impeller, but it was intended for the purpose of recovering heavy oil from the rejected gangue, and not for creating a froth. Thus, though it may be truthfully enough said that the Wolf process first proposed rapid agitation in connection with flotation, it cannot be taken that the proposal anticipated the agitation-froth method. However, in many quarters, any stick is good enough for beating the back of Minerals Separation.

The Alliance of Technical Societies.

On several occasions recently reference has been made in these columns to the modern tendency of technical societies to form alliances of one sort or another. Men of older generations used to think that one society was enough for pure science and one enough for applied science, and successively objected to proposals to have any other organizations than the Royal Society and the Institution of Civil Engineers. But with the spread of knowledge and investigation, and the continued subdivision of the various subjects, it became necessary, in spite of objections, to establish other societies for the purpose of affording adequate opportunity for discussion and interchange of opinion. It was then found that these societies could serve other purposes than the mere reading of papers, and that they could be made the representatives of the professions, both internally and externally. For the purpose of still further increasing their public influence, it became clear that the alliance of a number of societies representing various ramifications of one big industry would be a politic step. There is another reason for considering rapprochements of this kind, which weighs nearly as much. This is the opportunity it gives for combining funds for the erection of a suitable home and the formation of a central library. In some quarters federation, or even amalgamation, has been proposed, but with the exception of the federation of the provincial mining societies under the name of the Institution of Mining Engineers such schemes have not found favour, chiefly because the qualifications for membership of the various societies differ too widely. Consequently the limited, as contrasted with the full, partnership has been adopted in this country. Among notable alliances formed or proposed may be mentioned that between a number of chemical societies, and another between the mining and metallurgical institutions. As particulars of these have already been given in these columns, nothing further need be said here.

In the Overseas Dominions steps have been taken in Australia and South Africa to bring together the various engineering societies. In Australia there are twelve societies involved in the negotiations. Of these, the Australasian Institute of Mining Engineers, the Institute of Local Government Engineers, and the Electrical Association of Australia have the whole of the Commonwealth as their field. The other societies are the Victorian Institute of Engineers, the Engineering Association of New South Wales, the Queensland Institute of Engineers, the Northern Institute of New South Wales, the West Australian Institute of Engineers, the Sydney University Engineering Society, the Melbourne University Engineering Society, and the Tasmanian Engineering Institute. The progress of the preliminary proceedings in this matter has been hindered by the disinclination of the executive of the Australasian Institute of Mining Engineers to participate. At this distance, the ins and outs of the dispute between the executive and certain members, and between the executive and other societies, are not clear, and in any case, as we have not received the whole of the circulars and correspondence, it is incompetent for us to discuss the question in detail. It is only on general principles that we deplore the inability of the Australasian Institute of Mining Engineers to take part in the proposed consolidation of the Australian engineering societies.

In South Africa the societies interested in mining have taken the initiative, and are proceeding in no half-hearted fashion. Their scheme is ambitious and comprehensive, and they are energetically hunting for a millionaire, or millionaires, who will endow them with a suitable home. There is no talk of consolidation, but only of alliance for specified purposes. The three societies responsible for the scheme are the South African Institution of Engineers, the Chemical, Metallurgical, and Mining Society of South Africa, and the South African Institution of Electrical Engineers. We have said that the societies interested in mining have taken the initiative, and in so doing we claim the Institution of Engineers as a society largely identified with mining, a claim which will be generally admitted. The other societies which are being asked to join are the Association of Transvaal Architects, the Institute of Land Surveyors of the Transvaal, the South African Association of Analytical Chemists, the Geographical Society of South Africa, the South African Association for the Advancement of Science, the Astronomical Society, the South African Society of Civil Engineers, the Royal Society of South Africa, and the local branch of the Institution of Mining and Metallurgy. The proposal is to erect a home for all these societies in Johannesburg, if possible near the School of Mines Building. Here there would be offices for the various societies, several meeting rooms, and a club; also a library, the nucleus of which would be the Louis Seymour Memorial Library, now temporarily housed at the School of Mines. The societies would not only be provided with a home, but an organization would be formed through which the societies as a body could act in matters of technical and public interest. The cost of such a scheme in capital outlay and endowment would be £100,000, and the question of raising the money will require close inquiry. No doubt a large number of members of the several societies will be able to subscribe liberally to the fund, but, as we have said, the easiest solution of the matter will be the finding of a generous millionaire, or a millionaire who is ready to lay out his money on any plan that will help in the advance of the study of technology.

Steps are being taken in India to unify the various engineering associations. The proposal is that a new society, to be called the Indian Society of Engineers, should be formed, and that it should be more or less under the control or patronage of certain London engineering societies. In Canada the propaganda for alliance has been active during the last year or two, but it is not quite clear whether the Canadian Society of Civil Engineers, the name of which has recently been changed to the Engineering Institute of Canada, is willing to co-operate amicably with the Canadian Mining Institute.

It is not necessary on this occasion to dilate at any length on what has been done in this direction in the United States. The four big engineering societies have a common home, provided partly by the munificence of Mr. Andrew Carnegie and partly by liberal contributions from individual members of the societies. Various chemical societies have offices under one roof, and their interests are interwoven in many ways. The Americans have largely adopted the felicitous habit of holding joint meetings of societies. The only fly in the ointment of general content is the inability of the Mining and Metallurgical Society of America to come to terms with the American Institute of Mining and Metallurgical Engineers. Here the question of qualification for membership stops the way, as is the case when anything closer than an alliance is suggested in connection with the English societies.

We shall in the future give every opportunity in our columns for the ventilation of proposals and views in connection with the movement for the alliance of societies. The policy is of prime importance in the establishment of technical professions on a sound basis and in the interchange and collection of information.

Wider Scope for Mining Engineers.

The scope for the activity of the mining engineer who specializes in the non-ferrous metals is, comparatively, a small one in most parts of the world. This is true in normal times, and at present the limits are accentuated by the sudden slackening of demand for the industrial metals during the reconstruction period. In some countries, such as the United States, there is still plenty of work for the mining engineer and metallurgist, and, given favourable opportunity, there are openings in Mexico, South America, and Siberia. But mining operations cannot spread laterally for ever, and costs and impoverishment impose a stiff barrier in depth. It follows that some other methods of providing work for the mining engineer and of increasing the importance and influence of our profession should be devised. There are two ways in which this end may be gained. These are already well known, though not fully admitted as coming within the functions of the mining engineer. In the first place the mining engineer may turn his studies to the design and manufacture of plant and material required at the mine or metallurgical works; and second, he may follow the mineral or the metal further than the mine or smelter and engage in metal manufacture or the production of commercial chemicals. These industries are at present out of the official scope of the mining engineer and metallurgist, for they are not included within the purview of the mining schools, and engagement in them does not qualify for the membership of the mining societies. Nevertheless, as we have said, many mining engineers and metallurgists, as well as owners of mines and smelters, have crossed the strict line, greatly to their profit.

At the present time there is some prejudice against the mining engineer becoming a manufacturer of machinery. Such mining engineer has, quite against his own wish, to adopt some sort of camouflage in his capacity as manufacturer, in order that he personally shall not be mistaken for a tradesman. Surprise is expressed by superior people when it is found that a builder of head-frames is an Associate of the Royal School of Mines, or that a maker of rock-drills is a Member of the Institution of Mining and Metallurgy. Our view is that the making of plant and materials used at mines and metallurgical works is advantaged by the direct influence of men conversant with the objects for which the plant is used, and we therefore advise young mining engineers to note the opportunity offered by the careers here indicated.

In considering the possibilities of participation in the profits arising from the handling of mine products, it has to be remembered that the mining engineer's and metallurgist's business is supposed to end with the selling of the mineral or the metallic ingot. The copper and lead smelters in this country, generally when their supplies of ore ran short, turned their attention to the manufacture of pipes, sheets, wire, or white lead. Some of the copper smelters in America are extending their business in the same direction, but without waiting for the exhaustion of their ore supplies. In America and Australia the zinc producers are making galvanized iron, and many are engaged in the manufacture of zinc and lead pigments.

The controllers of the chrome ore output no longer part entirely with their raw material at the beggarly price that used to be offered by the chemical manufacturers, but share the latter's profits on a sound business-like basis. One of the companies owning wolfram mines is now producing tungsten powder from its own concentrate instead of selling its raw material on the open market. A big producer of bismuth minerals has its own works for the production of bismuth alloys and chemical compounds. The talc industry in the Transvaal has been made profitable by the manufacture of marketable articles instead of practically giving it away to people that wanted it. In Rhodesia a producer of arsenical ores is selling cattle dip in the local market. Certain firms of antimony smelters make antimonial pigments. The above examples show what has already been done, and indicates the general line of expansion to which we refer. The policy is capable of wide and increasing application. There are difficulties in the way, of course, due to the opposition of the middleman trader, and to the secrecy surrounding the processes and methods. It is just these obstacles that give zest to the attack, and in the case of the disposal of mineral products the ruinous prices offered by the middleman afford excuse for the attack on other people's businesses. It is not necessary here to give specific instances of possible chances of increasing mining profits by embarking in manufactures based on the products of the mine; though one case may be mentioned, that of the gold producers, who might be enabled to put their financial position in better order if they were empowered to participate in the manufacture of jewellery, gold leaf, etc.

The extension of the metallurgist's occupation into the domain of the manufacture and uses of metals has been noticeable for some time. The study of the behaviour of metals and alloys during the process of manufacture and during use is now recognized as one of the most important branches of investigation, and provides occupation for a great number of intelligent metallurgical chemists. The Royal School of Mines and the University of Birmingham are fortunate in having as professors of metallurgy men who are thoroughly at home in this branch of metallurgy, and their influence will tend to widen the opportunities of the student. While writing of professors, it is opportune to mention that the application of minerals to chemical manufacture is fully appreciated by the professor of mining at Newcastle-on-Tyne, as is evidenced by the fact that he now holds the presidency of the Society of Chemical Industry.

In tendering the advice contained in the foregoing paragraphs to members or intending members of the mining fraternity, we must not be taken as being desirous of interfering with present courses of study or with the established rules of membership of the societies. All we wish to do is to point out increased opportunities for careers in the profession, and methods of getting greater rewards for the labour of extracting metals and minerals.

REVIEW OF MINING

Introduction.—The country and the world generally is at present in a state of ferment owing to public and private extravagance, profiteering in food and clothing, and dissatisfaction among the earners of fixed wages. In mining circles the rise in the price of silver, the freeing of South African gold, and the development of the new Elmore process have been the features of interest. An English engineer acquainted with iron ore, Mr. William Selkirk, has gone to Spitsbergen, so some reliable details of the much advertised deposits should be available before long. In this issue we publish the first instalment of an article giving information relating to the mineral resources of Asia Minor, a country known in Continental mining circles, but of which little has been written in this country.

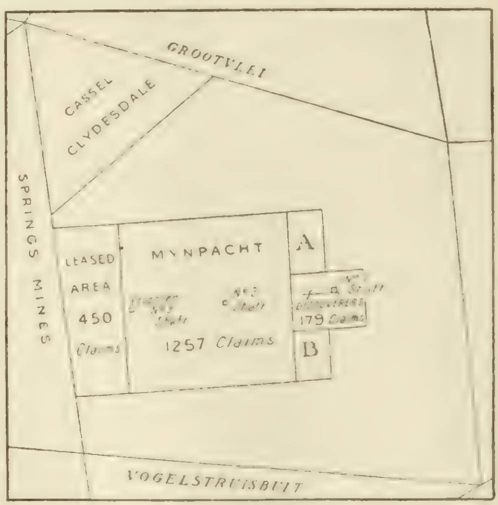
Transvaal.—The Commission appointed by the Government to investigate mining conditions, with particular reference to the position of the low-grade mines, has been sitting assiduously and hearing much evidence. Among other questions discussed were the removal of the colour bar and the granting of loans by the Government to mines temporarily in a tight corner. Judging by questions asked by some members of the Commission, the Government is not particularly sympathetic on either of these two points.

As recorded recently, the New Modderfontein appealed from the judgment which declared constitutional the imposition of taxation by the Transvaal Provincial Government on the gold mines. The Supreme Court confirms the lower court and has dismissed the appeal.

With regard to the above-named tax, its incidence depends on the ratio of profit to the output of gold. Companies making a profit of less than 10% of the output are not affected. For profits above this ratio, the tax is 1% on the profits when the ratio is from 10% and 15%, and advances $\frac{1}{10}$% for each additional percentage of profit, up to a maximum of 4%. Thus any company making a profit which is 45% or more of the gold output will pay 4% of its profit as Provincial Tax, while companies fighting for existence are free of impost.

The Consolidated Goldfields of South Africa, Ltd., has for some time wished to expand its field of operations, especially as few opportunities now offer for new gold-mining business in the Transvaal. The narrow confines of the memorandum of association have prevented the company employing its large reserve of capital in industrial enterprises. It has been deemed impossible to get the sanction of the courts to as sweeping a modification of the memorandum as is desirable, so the board has adopted an alternative plan. This provides for the formation of a new company with suitable memorandum and articles, and the whole of the shares of the new company will be held by the present company. The business will be handled by the new company, and its policy will be controlled by the shareholders in the present company.

Further details of the Daggafontein property as recently fixed between the company and the Government are to hand, and are given in the accompanying sketch map. The discoverer's claims (179) are around the No. 1 shaft, the



THE DAGGAFONTEIN PROPERTY

mynpacht area (1.257 claims) are to the west, the additional claims (450) leased from the Government are between the mynpacht and Springs Mines, and the areas A and B (173 claims) were received in exchange for New Geduld Deep mynpachts. The positions of No. 1 and No. 2 shafts and of the proposed No. 3 shaft are shown. It will be remembered that the gold-mining rights of the north-west corner of Daggafontein Farm were recently acquired by the Cassel-Clydesdale company. A large area of the farm remains in the hands of the Government.

On more than one occasion lately we have referred to the excellent results of development at the Government Gold Mining Areas. The results during the quarter ended June 30 are particularly good. During this time 6,980 ft. of development was sampled, of which 4,140 ft. was payable, averaging 20 dwt. per ton over a width of 52 inches.

The ore reserves at Modderfontein East at June 30 are reported at 850,000 tons averaging 8 dwt., all of this being in the old Cloverfield section. Locally the prospects are considered bright, as may be judged by the jump in the quotations for both shares and convertible debentures.

The inability of Kleinfontein to supply ore to its two milling plants to capacity continues to cause trouble to the engineers, who have been obliged more than once recently to modify the scheme of treatment. It is now announced that the Apex plant is to be closed temporarily, and that the output of the three sections is all to go to the Kleinfontein plant.

The annual meeting of the East Rand Proprietary Mines was enlivened by a discussion of Rand geology introduced by the irrepressible Mr. W. E. Bleloch. He urged that the wrong reef was being worked in the eastern or Blue Sky portion of the company's property, and that they had not found the "Van Ryn" which he claims would be the payable reef. He also holds that his Van Ryn reef extends all along the central Rand below the reefs now worked. A little cross-cutting and diamond-drilling might well be undertaken to investigate this point, but the evidence in the hands of the engineers of the big mining houses is all against such proposals.

The latest report from Rooiberg is more hopeful than some published recently. A lode has been disclosed by diamond-drilling in the Blaauwbank section 65 in. wide, and assaying 2·4% metallic tin, the middle 26 in. averaging 4·5%. The shaft is now being sunk in order that further investigation may be made.

Rhodesia.—The output of gold during June was reported at £214,215, as compared with £218,057 in May, and £225,447 in June, 1918. Other returns from Southern Rhodesia are as follows: silver 15,900 oz, copper 278 tons, arsenic 17 tons, wolfram 1 ton, chrome ore 4,963 tons, asbestos 833 tons, coal 43,295 tons, diamonds 39 carats.

The development of the lead-zinc ore deposits of the Rhodesia Broken Hill Company has been rapid during the last year or so, and the output of lead is now regularly maintained at about 1,200 tons per month. Orders have been given for the erection of two more furnaces, whereby the output will be doubled. Mr. S. J. Speak is about to go to the United States for the purpose of studying the latest practice in the treatment of zinc ores of this type. Arrangements have been made for securing the services of one of the geologists of the Rhodesian Geological Survey, Mr. A. J. C. Molyneux, in order that a thorough investigation of the geology of the district may be made. At the present time only No. 1 Kopje is being worked. Here the more leady portion of the oxidized lead-zinc ore is being worked by open-cut. Bores by churn-drill have proved the ore-body to go down 250 ft. A great many other outcrops are known, and are continually being exposed while clearing bush or digging foundations for buildings.

The Wanderer mines have been closed, and the last clean-up yielded 30 oz. of gold from slags. The plant has been dismantled, and is being sold.

Another Rhodesian gold mine, the Antelope, belonging to the Gold Fields group, finds its burden unbearable. The intrusion of a dyke, the scarcity of labour, and the mounting of costs have combined to extinguish the profit. The property is not suitable for tributing. The board has no alternative but to cut expenses and use the stores in working the reserves as long as it pays to do so.

The Government has appointed a commission which is to proceed to South Africa to examine the claims of the British South Africa Company with regard to compensation for administrative expenditure. A year ago the Judicial Committee of the Privy Council decided that the public lands were the property of the Crown and not of the company. It was claimed, therefore, by the company that much expenditure that it had incurred in administration should really have been borne by the Crown. The amount of the company's claim is £7,569,435.

West Africa.—The output of gold during June was valued at £106,612, as compared with £100,827 in May, and £120,273 in June, 1918. The normal rate of output at Ashanti Goldfields has been restored, after the recent accident to the hoisting gear.

Diamonds were recently discovered in West Africa by Mr. A. E. Kitson, the Government Geologist. They occur in gravels in a tributary of Birrim River. The diamonds are small, but of high quality. We shall give some particulars in our next issue.

The Fanti Consolidated Mines is about to form a subsidiary to take over the bulk of the manganese properties at Dagwin, and has made a contract for the sale of the ore to the United States, at the rate of 100,000 tons per year for five years.

Nigeria.—A new company has been formed, called the Associated Nigerian Tin Mines, Limited, to amalgamate the New Lafon Tin Fields and the Kassa-Ropp Tin Co., and to acquire the Yelwa property. The properties have been examined by Mr. J. M. Iles, who reports that the proved contents of the various properties are 2,000 tons, 666 tons, and 1,536 tons of tin concentrate respectively, and that the prospects are excellent.

Australia.—The strikes at Kalgoorlie and Broken Hill continue. At the Broken Hill South a disastrous fire has occurred, which, there is reason to believe, was deliberately planned by a section of the disaffected employees. At No. 1 shaft the headgear, ore bins, breaker house, and mill engine house have been destroyed. The new power house, winding engine, and most of the concentration plant were saved. The mine workings were not affected.

Cable advices announce that the Mount Morgan company produced 6,268 tons of copper and 92,983 oz. of gold during the year ended June 1. The ore raised was 323,264 tons, of which 190,604 tons went to the concentration plant and the rest to the smelter. At the smelter the material treated comprised 128,543 tons of ore, 17,348 tons of jig concentrates, and 43,259 tons of table and flotation concentrates. Owing to the difficulty of marketing copper recently, it was decided to increase the yield of gold, and with this object a larger proportion of high-grade silicious ore in the upper levels was mined. As stated in our last issue, the mine was closed on June 15 owing to the strike of transport workers, but operations were partly resumed at the end of June. The dividends for the year absorbed £100,000, being at the rate of 10 per cent.

The Mount Boppy gold mine in New South Wales is the victim of another misfortune, this time in the form of an epidemic of influenza. All operations had to cease about the middle of July, and have not yet been resumed. The district is troubled with drought, but the water supply is sufficient for present purposes.

The output of tin concentrate in Tasmania continues to decrease. The figure for 1918 was 2,256 tons, as compared with 2,637 tons in 1917, 2,854 tons in 1916, and 4,010 tons in 1913. Of the 1918 output 673 tons was produced by three alluvial companies: Briseis 321 tons, Pioneer 263 tons, and Arba 89 tons; while among lode mines the Mount Bischoff produced 458 tons, the Bischoff Extended 155 tons, and the Royal George 111 tons. The Mount Bischoff and the Briseis have been the biggest producers for many years, and their 1918 outputs compare with 1,180 tons and 514 tons in 1913.

India.—We recorded two months ago that the developments at the Hutti (Nizam's) gold mine, in Hyderabad, were discouraging, and that the directors were uncertain as to the future. Another meeting of shareholders has since been held at which it was announced that exploration at depth continued to disclose no ore, though the lode-formation is clear enough. It was proposed that exploration should be continued as long as the present ore reserves provide the cost. These reserves will last until October. If an ore-shoot is discovered in the meantime work will continue, but if not it will be necessary to cease operations and wind up the company.

Malay.—A company called the Southern Perak Dredging Co., Ltd., has been formed, with a capital of £125,000, to acquire tin-dredging property on the banks of the river Chenderiang. The report on the property was made by Messrs. Aylesbury & Nutter, and Messrs. F. W. & R. Payne are the consulting engineers. The control is the same as that of the Malayan Tin Dredging Co. It is proposed to build a dredge with a capacity of 100,000 cu. yd. per month, and the yearly output of tin concentrate is estimated at 450 tons.

Cornwall.—The breath of the average man interested in mining has been quite taken away by statements emanating from Mr. Albert F. Calvert in connection with his operations in the Gwinear district. These statements are found in articles or advertisements appearing in certain newspapers. The chief property is the Trevascus, and there are also a number of dumps. The Trevascus has been known for many years as a wide lode containing very low grade complex ore. Mr. Calvert reports that his average assay-values up to date give 30 lb. of tin per ton. All we need say is that we do not accept Mr. Calvert as an authority on Cornish mining, or, for that matter, an authority on mining at all. We hope he will never offer these properties to the public, but keep them for himself. The company through which he works is the Jumbil (Nigeria) Tin Areas, Ltd., a derelict organization, the registration of which he purchased for this particular purpose.

The Berrida (Nigeria) Tin Fields, Ltd., which holds the lease of the Poldice mine near Redruth, is in want of further capital for the plant for treating the dumps. Shareholders are invited to subscribe for 25,000 7% debenures at the price of £6. 8s. per £10. Out of the £16,000 thus raised, £10,000 and interest due will be paid to the bank in satisfaction for an advance, and the remainder will be available as working capital.

Oil in Great Britain.—A company has been formed called the Oilfields of England, Ltd., with a capital of £250,000, for the purpose of sinking oil-wells on the Kelham estate, near Newark, in the county of Nottingham. As has already been recorded in these pages, petroleum was found some years ago in a narrow bore-hole put down in connection with coal exploration. The oil was found at a depth of 2,440 ft. in a seam of coarse sandstone 13 ft. thick. For eleven months the flow of oil was 5 to 6 gallons per day, but the hole was subsequently plugged. It is now proposed to sink three oil wells. Reports on the property and the oil have been made by Mr. James Ford, who did the drilling, and Mr. Arthur W. Eastlake is technical adviser to the company. It is said that the sulphur content is not more than 0·59%.

The Anglo-Persian Oil Co. has made a bid for the control of the Scottish oil-shale industry, offering to purchase the ordinary shares of the Pumpherston, Broxburn, Oakbank, Young's Paraffin, and John Ross companies. The plan calls for the formation of a new company called the Scottish Oil Co. The Anglo-Persian will supply crude oil for refining to the Scottish works in order to enable the present refineries to run at full capacity.

The English Oilfields, Ltd., of which Dr. Forbes-Leslie is the leading spirit, is conducting development work energetically on the Norfolk oil shales. It is reported that deeper seams recently discovered are lower in sulphur than those on the outcrop. At depth also free oil has been found.

Canada.—It is announced by cable that the mines at Cobalt have been closed owing to a strike. Our Toronto correspondent tells of the position, but at the time he wrote the prospects of a favourable settlement were greater than have eventuated. It appears that the employees of the hydro-electric power companies are also disaffected. The miners demand a minimum daily wage from \$4·50 to \$5·00 according to the nature of the work done, with a bonus of 25 cents on 80 cent silver, and a similar increase for each additional 10 cents per oz. A 44 hour week is demanded, board at \$1·00 per day, increased allowances for overtime, and other changes in working conditions.

In our last issue we mentioned the proposal for amalgamating the Kirkland Lake Proprietary, Tough-Oakes, Burnside, and Sylvanite companies, owning gold mining properties at Kirkland Lake, Ontario. The financial scheme has since been published, and has been sanctioned by shareholders. A new company is to be formed with a capital of £1,000,000, of which £800,000 will be represented by shares alloted to the several companies, while 200,000 will be issued for cash when required. The amalgamation also includes the Sudbury Syndicate, Ltd., and Aladdin Cobalt, Ltd.

Mexico.— A company has been formed called the Mexican Corporation, Ltd., with a capital of £1,000,000, for the purpose of acquiring mines in Mexico. The directors are Messrs. F. W. Baker, J. A. Agnew, F. A. Govett, A. Stanley Elmore, Walter McDermott, Herbert Guedalla, and Lord Brabourne. The company belongs to the Camp Bird-Santa Gertrudis group.

Russia.—The political position in Russia is difficult to understand. The Bolsheviks appear to be strong on the Archangel front and in the Urals, while the better element in South Russia is winning its way northward. In Siberia the position continues fairly hopeful. Mr. T. J. Jones, engineer to the Irtysh Corporation, has just arrived at Ekibastus and reports that affairs generally are satisfactory, operations being self-supporting.

The Sissert company has issued a short statement describing the events of the past eighteen months. The Bolsheviks held the property from November, 1917, to July, 1918, and communication was restored with England in December last. During the first five months of 1919, the output of the single blast-furnace was 3,200 tons of pig iron, and during the same time 3,500 tons of steel ingots were produced, which were used in the manufacture of wire and sheet iron. A second blast-furnace was started on June 1. The production of copper was greatly restricted owing to the lack of coke, and only the reverberatory furnace was used, the output of which was 110 tons. The anthracite mines at Egorshino have been unwatered and production has been resumed. The bituminous coal mines at Minusinsk have been producing since January. As regards the Degtiarsky copper deposit, in which 3½ million tons of pyritic ore, carrying 2·77% copper, had been proved before the war, it has been decided to treat this ore in Ramen furnaces, making sulphuric acid first, then leaching for copper, and finally briquetting the remaining oxide of iron. It was originally intended to adopt pyritic smelting for the treatment of this ore, but the high quality of the iron oxide obtained, practically free from phosphorus, has made the alteration of policy advantageous.

THE MINERALS OF ANATOLIA

By NORMAN M. PENZER, B.A., F.G.S.

The author gives particulars of the mineral deposits of part of Asiatic Turkey, about which little is known in this country, though the Germans compiled records some years ago.

INTRODUCTION.—Now that peace is signed with Germany the question of the proper administration of the former Turkish Empire becomes of prime importance. The vast economic potentialities are but little realized in this country by the ordinary well educated man, and even the great leaders of industry are largely in the dark. The object of this article is to draw the attention of the nation to the valuable mineral deposits of a very large area and more particularly of Anatolia.

By the term Anatolia the writer means to denote not the whole of Asia Minor, known by the Turkish name "Anadolu," but only that portion lying west of longitude 37° E., that is to say west of a line starting in the south about 40 miles east of Alexandretta, skirting the eastern boundary of Adana, and running through the centre of the town of Sivas to a point on the coast about 80 miles east of Samsun. Thus it will be seen that the silver-lead mines of Bulgar-Maden in the Vilayet of Adana and the copper mines of Sivas will be included in our survey, while the famous copper mines of Arghana Maden in Diarbekir will be excluded.

In reading the following account of the mining in Anatolia, it should be remembered that the Turkish Empire is divided up into provinces called vilayets, which are administrated by a Governor-General called a Vali. These vilayets vary in size from about 12,000 square miles to over 39,000. Each is divided up into Livas, Sanjaks, or Mutessarifliks. These are all governed by a Lieutenant-Governor, locally called a Mutessarif. These, again, are divided into Kazas governed by a Sub-Governor or Kaimmakam, and finally the Kaza is divided into Nahiyes, which are administered by a Mudir. The Vali represents the Government in practically all matters, and the Mutessarif sends his reports to headquarters through the Vali except in such cases when the Sanjak has become an independent State, and then the Mutessarif communicates direct. The number of these independent Sanjaks has lately been on the increase owing to political reasons which do not concern us here.

The vilayets with which we are concerned in the following article are as follows: Brusa, Aidin, Konia, Angora, Castamuni, Adana, Trebizonde (in part), Sivas (in part). The Sanjaks (independent) are Bigha and Ismid.

The chief products of the country are wheat, cotton, dried fruits, oil, silk, mohair, carpets, wine, and the numerous mineral products about which we are especially concerned here.

Mining has been carried on in Anatolia from time immemorial, and in the seventh century B.C. we read of the Lydians issuing the first coins of the world, composed of a mixture of gold and silver known as "Electron," which they mined from the so-called "Anatolian goldfield." Some of the famous meerschaum mines are said to be over 2,000 years old, and were worked by the early Greeks, but to what use they put the meerschaum, whether for pottery, personal adornment, carving, or modelling, is quite unknown. Although mining in Anatolia began at perhaps 2,500 years ago, yet to-day the mining resources are little known and have been very incompletely studied, while much land is still absolutely unexplored.

Although there is no doubt that Anatolia is very wealthy in minerals, we should not be misled by descriptions in which we read of Asia Minor being practically inexhaustible as regards mineral wealth. At present it seems unlikely that the production could ever compete with that of Caucasia and Southern Russia, but until a far more detailed survey has been made, it is impossible to say anything for certain one way or the other.

The chief reason why the minerals of Anatolia have been so little developed is lack of communications. The Turkish Government builds (sometimes) but never repairs, and a road suitable for fairly heavy cart traffic one year, by the next will be covered with grass. In consequence transport from most of the mines is limited to camels and mules, and the latter always prefer the ancient rugged hill tracks which have been used for over 2,000 years. A glance at the map will show how far from the railways many of the mining centres are, and also how deposits in certain areas have been unworked entirely owing to lack of communications.

The mining industry of Anatolia has had little encouragement from the Turkish Government. They seem to look upon it as a means for obtaining a profit on the sale of concessions. There was no difficulty in obtaining a "permis de recherche," but when it came to serious development, obstacles of every kind

were put in the concessionaire's path. The result was that concessions were obtained not with a view of working the mines but of passing them on at a higher price, or holding them for some favourable development, such as the death of the Sultan, or a sudden rush for concessions such as has only recently occurred.

There is another reason for the lack of mining operations, and that is the scarcity of fuel for use in the smelting works. Coal is hardly used at all, again owing to lack of communication, as it has to be brought from great distances, and so wood is used, but this is also very scarce. As all the wood is usually wanted for smelting purposes, mining is usually carried on without timbers at all, and so, as soon as the walls of the mines fall in, the mine is immediately abandoned. Pumps are practically unknown, and when floods occur the mines have again to be abandoned. Thus around Eskishehr, hundreds of deserted meerschaum mines are found which could easily be made workable again with a pump and a few strong timbers.

Finally there is the question of man power. The average Turk hates working underground, and as soon as he has made enough money to keep himself for a time he stops working. Native capital has not played its part in the developments of the minerals of Anatolia, and it is Europe that has chiefly exploited the mines in the past, although owing to lack of communications most of the exploitations have been confined to mines near the sea or the main railways. The Germans for a long time have had their eyes on these mines, and after the War started a remarkable rush for concessions has been noticed. The Turks began to copy the Germans, and, whereas in 1915 only eighteen applications were made, in the last few months of 1917 no less than ninety concessions were demanded in the vilayet of Aidin alone. The Turks, however, still buy concessions as a gamble, and in Brusa have found ready buyers in the Germans who know well what they are doing.

German and Austrian engineers have minutely surveyed the vilayet of Brusa, and declare it to be rich from a mining point of view. So great interest indeed have the Germans taken in this district that in 1917, according to the *Deutsche Levande Zeitung*, a society was formed at Munich for the express purpose of studying in detail the minerals of Asia Minor with a view to future German activities.

The only place where up-to-date methods of mining are employed is in the marble quarries on the Marmora, where electricity has been in use since 1912. There is naturally great scope in the Turkish mines for electric plant, steam turbines, turbo-electric generators, turbo air-compressors, etc. Competition in supplying these fittings is bound to come in time, but if all the mining concessions are allowed to fall into German, Austrian, and Turkish hands, not only will a large revenue derived from the minerals be lost to the British, but the supplying of the mines with machinery will also be lost, and all the plant will bear the label " Made in Germany ".

In view of the fact that at present the British Government is opposed to the raising of funds in this country for the development of areas outside the British Empire, every endeavour should be made to raise as large a part of the requisite capital as possible from Turkey, although the management should remain in British hands. Such a policy would have the additional advantage of conciliating the well-to-do Turk, who naturally might resent the apparent exploitation of his native land by a foreign nation, while he would appreciate the technical skill and commercial ability and integrity of a British board of directors.

No special order of minerals will be adopted in the description following, except that the newly discovered and most unimportant will be dealt with last. In some cases two or more minerals will be taken together as they occur in close association.

The list of minerals is as follows: Gold and Silver, Lead, Zinc, Meerschaum, Manganese, Antimony, Mercury, Coal, Lignite, Emery, Borax, Chromium, Iron, Copper, Rock-Salt and Saltpetre, Lithographic Stone and Marble, Kaolin and Fuller's Earth, Cement and Lime, Sulphur, Nickel, Arsenic, Bitumen, Petroleum, Opals.

GOLD.—Anatolia can hardly be recognized as a gold-producing country, although according to records of ancient writers and recent excavations it was at one time famous for its goldfields.

The goldfields were two in number, that of Anatolia, and that of the Pontic area. The former of these comes within the scope of this article, and a short account of it chiefly for historic purposes is of interest.

The Anatolian goldfield stretches in semicircular form from the Dardanelles to a point about 40 miles below Smyrna and just opposite the island of Samos. The gold-bearing river of the district is the classical Hermos with its equally historical affluent the Pactolus, from which the wealth of the Lydian kings was said to be derived and which is described by Virgil, Juvenal, Seneca, etc. In Strabo's time, at the beginning of the Christian era, the production had considerably decreased, and a writer contemporary with Nero refers to it as being "formerly" auriferous, and suggests the primary derivation of nuggets from Mount Tmolus (the modern Boz Dagh) where the Pactolus rises. To-day the peasants make a scanty livelihood by washing the gravels, and it seems possible that the main riches of the district were exhausted fifteen centuries ago.

Lodes are also found in this neighbourhood. The largest was of low-grade arsenical quartz 15 ft. wide, but the majority are far smaller and usually contain a higher percentage of gold. The gold content varies from a mere trace to about 3½ oz. Deep workings have been found on Mount Tmolus and Mount Sipylus (the modern Manissa Dagh) whence Crœsus is supposed to have derived his wealth. From the writings of Thomæ an average sample of a ½ ton lot of the ore of this district was made up as follows: gold 13 dwt. per ton, silver 5 oz. 13 dwt. per ton, lead 7·6%, copper 2·2%, zinc 2·7%.

Among the ancient workings which have been discovered near the Dardanelles may be mentioned Serdjiller, which place corresponds fairly closely to the ancient Astyra. The country of the workings is mica schist, overlain and intruded by Lower Tertiary igneous rocks which have been described by various writers as trachyte, liparite, andesite, and basalt. Thus it has been suggested that there is probably some analogy, and, indeed possibly genetic connection, between this auriferous area and those of Transylvania and of Eastern Serbia. The quartz veinlets in the volcanic rocks carry argentiferous galena, blende, pyrite, chalcopyrite, stibnite, and a little free gold. The gold content is, however, very low. Concessions of the Serdjiller deposits are in the hands of a company controlled by John Taylor & Sons.

SILVER-LEAD-ZINC.—The chief mines in Anatolia producing silver-lead and zinc are those of Balia-Karaïdin in Brusa, and Bulgar-Maden in Konia. The mines of Balia-Karaïdin date from very ancient times, and the old mines of Gümüsh, Koda, and Karaïdin for a long time belonged to the Greek Company of Laurium at Athens. In 1892 the "Company of the Mines of Balia-Karaïdin" was formed at Constantinople with a capital of 6,600,000 francs. In 1901 there were about 1,600 men employed who produced 7,000 tons of argentiferous galena containing 70% of lead and 0·125% of silver, 3,000 tons of blende containing 40% of zinc, some hundreds of tons of calamine, and a little pyrites. In 1910 the output was 12,000 tons of lead and 3,000 tons to 4,000 tons of blende. In 1913 the output amounted to 13,076 tons of lead and 5,000 tons of zinc ore containing 42% of zinc. After the war commenced the mines were shut down, but were recently reopened, and a contract was placed by the Turkish Government for 1,000 tons of pig lead. The mines are furnished with up-to-date smelting and refining plant, so that a good quality lead is produced. In all probability the 1,000 tons was used for shrapnel and rifle bullets in Constantinople.

The Bulgar-Maden mines, situated a few miles south of the Konia-Adana line in the vilayet of Konia, have been worked by the peasants for nearly eighty years; they sell to the Turkish Government at a fixed price. Owing to lack of initiative by the Government, little has been done, although the conditions are most favourable for cheap work. The deposits are the result of contact action of micro-granulites which have been intruded into the Paleozoic limestones. Two separate zones have been noticed extending all along the metalliferous formation from Bulgar-Maden to Kizil Tepeh. The ore is taken to the village on mules, and smelted with the aid of charcoal. The smelting appears to be unsatisfactory, as the metal content of the slag is high. The work is only carried on in the warmer months, as in the winter the workings are snowed up. The annual yield is about 3,205 kilogrammes of silver, 7,000 grammes gold, and 400 tons lead. In 1892 the ore extraction was 20,000 tons containing 20% of lead and 6,500 kilogrammes of silver, and going 30 to 40 grammes of gold to a ton of lead. These figures increased just previous to the war and the mines yielded ore containing 75% of lead and from 1½ to 3½% of silver. In Konia there are also silver-lead deposits at Karahissar and Bulgar Dagh, the latter of which is worked by the Government. They yield ore averaging 75% of lead and 1·5 to 3·5% of silver. At the outbreak of the war a lead mine was about to be worked near the Dardanelles at a point south-west of Lapsaki, quite close to Bergaz, but as far as is known no operations have been commenced.

In the vilayet of Aidin silver-lead mines occur near Balia, which from 1911 to 1913 yielded an average of 14,000 tons of lead. Zinc is found at Kirasaliyaila and Bergama, where the deposits contain from 20 to 50% of zinc. In Angora, silver-bearing lead ore is found at Ak-Dagh-Maden, Denek-Maden, and Elma-Dagh; all these mines are State-controlled, but the last named was abandoned many years ago. In Castamouni the argentiferous lead mine at Kurré has been abandoned owing to insufficient means of transport and communication. In Adana, besides the silver-lead mines of Bulgar-Maden already noticed, are those at Karalar and Hadjin, while silver, lead, and zinc occur at Iotape, and zinc alone at Anamur. There are probably other deposits in the northern part of the vilayet, but owing to lack of communications and transport no exploitation has been carried on. Since the war reports have been received of two lead mines (probably argentiferous) twenty-four miles north-east of Bulgar-Maden. One is at Delik Tash, 15 miles due east of Bereketli Maden, and the other nine miles north-west of Delik Tash. No figures are yet to hand.

It is reported that in 1916 the Germans obtained 70 concessions for the working of silver-lead mines in Asia Minor, probably in Brusa and Aidin.

The silver-lead mines of Kebah Maden do not come within the area under discussion.

MEERSCHAUM.—As was stated in the introduction, the mining of meerschaum dates back to the days of the ancient Greeks, although it is unknown to what use the meerschaum was put. Apparently no special use was made of it until the beginning of the eighteenth century, when it was carved into pipe bowls. The story of the discovery of the virtue of meerschaum for pipe-making is as follows: In Budapest there lived a shoemaker, Karol Kovacs, who made as much money by carving wooden pipes as he earned by his regular trade. One of his wealthy pipe patrons was Count Andrassy, who, when travelling in Asia Minor in 1723, was presented with a lump of meerschaum, which he gave on his return to Kovacs with orders to make a pipe as an experiment. Two pipes were carved from the lump, but while working on one of them it slipped from his hand on to a disc of wax used in his shoemaking trade, leaving a stain on the pipe. Kovacs kept this pipe for himself, and was surprised to notice that, as he smoked, the wax-stain turned a clear brown, and the taste got sweeter, so he waxed and polished the bowl all over, which in time assumed a dark brown colour evenly distributed over the pipe. The original pipe is still preserved in the Budapest Museum. This hydrated silicate of magnesium became known in Germany as meerschaum, in France as écume de mer, in Italy as schiuma del mare, and in England as seafoam, although to-day we always use the German word. Meerschaum presents a globular appearance and seems to bulge out in circular form at different places, and thus arose the name likening it to the scum of the sea. The first account of meerschaum the author could find in English was in Tilloch's Philosophical Magazine for 1799 (vol. 3, p. 165) where it is referred to merely as "sea froth."

Although the chief source of the world's supply is Asia Minor, it has also been found in Moravia, Bosnia, Samos, Greece, Utah, Spain, and New Mexico. Both the quantity and quality are, however, much inferior to that found in Asia Minor. A hydrous silicate of alumina was found near the Richmond river in New South Wales, with similar characteristics to meerschaum, but apparently no use was made of it. The soft white earthy mineral from Langbanshyttan, in Vermland, Sweden, known as aphrodite, is also closely related to meerschaum.

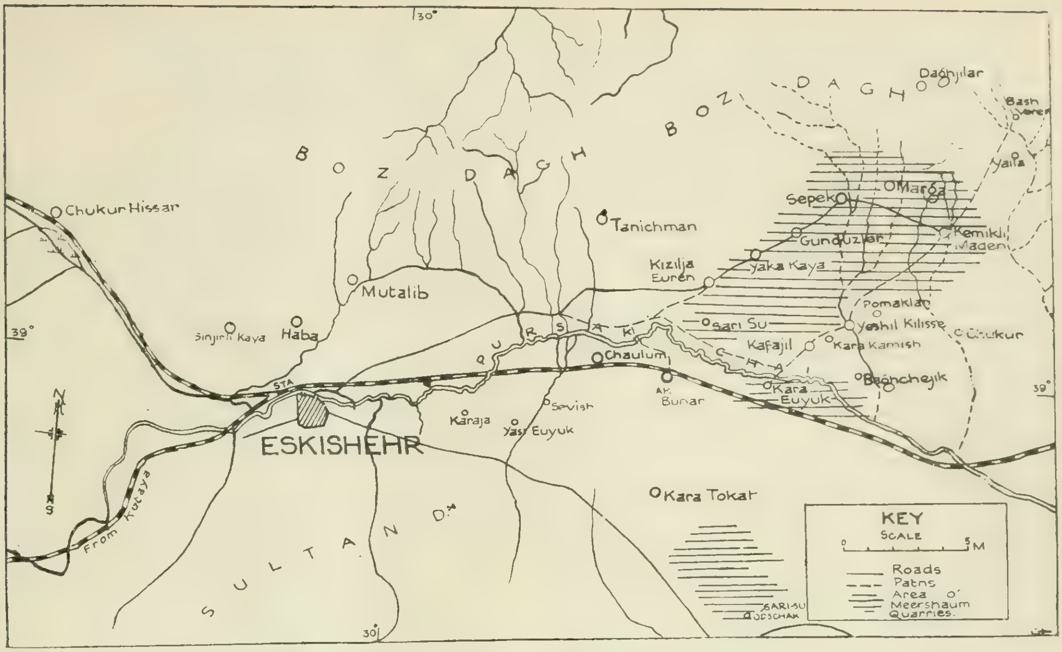
The centre of the industry in Asia Minor is Eskishehr, the ancient Dorylæum, situated in the eastern portion of the vilayet of Brusa at the junction of the Angora and Konia lines. The town lies on the river Pursak in lat. 39° 47′ N. and long. 30° 25′, is situated on a plateau at a height of about 2,500 ft., and has a population of over 30,000. Around the town is a higher plateau forming a flat trough, which is surrounded on the north, south, and west by mountains, while to the east is a flat plain interrupted here and there by hills which give an irregular character to the plain. At the foot of the mountains are the meerschaum deposits, which are alluvial and probably lacustrine; most of them are about 20 miles from Eskishehr.

The chief mines on the eastern slopes of the Boz Dagh are as follow: Sepek, Marga, Jeni-Damar, Eski-Damar, Kül-Odschak, Gündüzler, Kemikli Maden, Yaka Kaya, Jarmalar; and those farther south: Kara-Euyak, Sari-Odschak. There are other mining centres, but as the locality of the operations changes according to the productivity it is impossible to give full details.

Sari-Odschak can be taken as a typical meerschaum mining village. It consists of about 150 houses which are solely occupied by men. The miners are of varied races, Turks, Kurds, Tartars, Persians, Greeks, Armenians, &c., not to mention stray criminals and deserters. The men work either on their own account or for a contractor. A permit to dig anywhere can be obtained for five Turkish lire. Wages are low ($1\frac{1}{2}$ lire a month) and added to this is the fact that the Government has taken no steps to fight the malaria which is a truly endemic plague. Heaps of loamy earth and clay lie in all directions marking the spots where mines, in many cases, are deserted. Each mine is about 60 to 100 ft. deep, while the entrance is roughly 3 ft. square. The miner works his way through the clayey upper stratum until he reaches the meerschaum deposit among the serpentine. His only tools are an axe and a shovel, and he works by the light of a petroleum lamp. He descends the mine by means of his feet and elbows, and if the mine is deep he is lowered by a wooden hand winch, which is also used to bring up the meerschaum in baskets. He then makes horizontal galleries, which as often as not have no supports whatever; sometimes the roof or sides fall in, and the men are embedded in the mine. There are practically no pumps, so that an inrush of water means the desertion of the mine and often the death of the miners.

The meerschaum itself is found in lumps varying in size from an egg to a football. These are surrounded by a layer of wet earth, which when removed display a rough surface. The blocks are white in colour, but sometimes have a faint red, yellow, or grey tint, which usually disappears on drying. They have a fairly smooth conchoidal fracture, and are opaque, dull, and soft, being softer than calcite but harder than gypsum. The mineral absorbs water and can be formed into a paste.

The miner sells the meerschaum in sacks to the Isnaf, or small trader, at about 200 piastres a sack. The Isnaf then takes his goods to Eskishehr by ox-cart, where he either sells them to the Tydschar (wholesale man) or to the meerschaum depots which for the most part belong to Viennese firms. No raw meerschaum is allowed to be exported, and so in all cases the preliminary preparation is carried out at Eskishehr. This consists of removing the outer earthy layer, cutting out all bad patches, and rounding off the surfaces. This has to be done while the material is moist, and in all deposits there are moist cellars for storing the meerschaum as soon as it arrives from the mines. The next process is the drying, which in summer is done in the open air, and in winter in special drying chambers. This lasts a week, as the drying has to be done slowly to prevent cracking. During the drying the meerschaum loses about two-thirds of its weight, and becomes harder and acquires a snowy white colour. If, however, a piece is yellowish or reddish throughout it can never turn pure white. No smoke is allowed to enter



Map of the Meerschaum-Mining District.

the chambers, as in this way the pieces would get coloured. The final touches are then given to the meerschaum. It is smoothed by means of horsetail grass and polished with a flannel dipped in warm water and waxed. The meerschaum is then packed for transport.

There are thirteen recognized qualities, which are assorted into four principal sizes, and four minor sizes. They vary according as to how many pieces go to a box, the boxes being either of $6\frac{3}{4}$ by $13\frac{1}{2}$ by 28 inches or $7\frac{1}{2}$ by $14\frac{3}{4}$ by 32 inches. The former size is used for lumps of the three largest sizes only. The box is built round the meerschaum, each piece of which is wrapped in cotton, and if one piece is removed it will be impossible to put it back.

Before the Anatolian railway was built transport was by camel and mule to the sea of Marmora at Ismid, whence the boxes were shipped to Constantinople. To-day transport is effected on the Anatolian railway to Constantinople. From here the meerschaum goes to Vienna via Trieste, where it is carved into elaborate pipes, mouth-pieces, &c., and sent to Berlin, Paris, Brussels, London, New York, &c. The export of meerschaum is on the decline, owing on the one hand to lack of enterprise and general slackness of the Turkish Government, and on the other hand to the introduction of the briar pipe into France in 1855.

The following figures show the number of boxes exported over a number of years. The 1914 figure is only approximate, and probably rather too high: 1855, 3,000; 1865, 8,000; 1869, 11,500; 1892, 5,700; 1904, 3,000; 1914, 2,000.

The centre of the carving industry in Germany is Ruhla in the Thuringian Forest, where the factories were first founded in 1767. In 1911 about 1,200,000 genuine and non-genuine (made of compressed meerschaum waste) pipe-heads and cigar-holders were manufactured. This output is about one-tenth of what it was in 1865–6. In 1911 the annual export of pipes and holders was estimated at £35,000. There are also manufacturing centres at Lemgo and Nuremburg.

As a material for pipe manufacture meerschaum is all but ended, although with a little more enterprise a far greater supply of the raw product could be obtained. The pits, deserted on account of there being no timbers or pumps, could be made to work again, yet, unless some new use is found for meerschaum there is probably sufficient in the present state of affairs to meet demands. Whether meerschaum could be advantageously used for whitening clothes, as a dentifrice, or in the manufacture of some electrical article, remains for chemists and scientists to discover.

(To be continued).

MODERN ROCK-DRILL PRACTICE.

By DAVID PENMAN, B Sc., M.Inst.M.E.

(Concluded from July issue, page 28.)

ROTATION OF DRILL STEEL.—In percussive drilling it is imperative that the drill steel be turned through a small angle between successive blows, otherwise the bit will soon begin to stick fast in the hole and further progress become impossible. In hand drilling the proper rotation of the steel is a simple matter in the hands of a skilled driller, but with the large and clumsy forms of power drills first introduced the turning of the bit was quite a different proposition. Two methods of overcoming the difficulty presented themselves. Either the front head, drill steel included, had to be rotated, or only the piston to which the drill steel was attached was revolved, the rest of the machine remaining in a fixed position. With large reciprocating drills the first method was out of the question, although it has been applied successfully in light modern stoping drills of the hammer type, in which, as will shortly be explained, the drill cylinder and the chisel are rotated by hand. The second method was so obviously the only feasible one that development along the lines of automatic rotation of the piston was rapid. Finally, in 1866, Darlington and Jordan invented the rifle bar and ratchet mechanism which was destined to prove one of the most noteworthy advances in the whole history of rock-drills. The device has since been modified and improved by many inventors and manufacturers, and to-day forms an integral part of almost every automatically rotated drill on the market.

In machine drills the rifle bar and ratchet has been employed to produce two somewhat different results. In one method there is no possibility of the piston missing rotation when it ought to rotate unless breakage of some of the parts takes place. This is called "non-slip" rotation. In the other system the ratchet wheel is held by friction, and should the drill steel become excessively difficult to turn through sticking or friction in the bore-hole, the rotation system slips and the chisel is not rotated during that stroke. This is termed "slip" rotation. Until a few years ago non-slip rotation was employed extensively, but in modern reciprocating drills, owing to the obvious risk of twisting of the rifle bar and breakage of parts, it has given place to the modification which allows slipping on excessive friction. Practically all modern standard drills employ slip rotation. Rotation of the piston and drill steel always takes place on the back stroke, the forward or hitting stroke being straight. In the Chicago Giant and Slogger drills and others the ratchet teeth are on the inside of the ring surrounding the pawls, while the latter, two or three in number, are placed in the head of the rifle bar. The Sullivan and Siskol drills, however, have the ratchet teeth on the rifle-bar head and the pawls in recesses in the slip ring. It is claimed that by having the teeth outside the pawls the teeth are stronger, since their bases fall on a larger circle, and that for a given space they can be more numerous, giving a better rotative effect. A further advantage of the teeth being in the slip ring is that it is the least expensive part to replace.

The commonest arrangement for producing rotation of the drill steel in the hammer type of drill is to use the rifle bar and ratchet as in the piston drill and in addition to have straight grooves in the front of the piston or hammer which slide in similar straight grooves in the drill-holder. This arrangement is adopted in the Holman cradle hammer-drill, the Leyner-Ingersoll, the Jackhamer, Cochise, and Wizard. In hammer-drills made by the Climax Company, and in the Flottmann, Waugh, and Sullivan Rotator drills, however, the use of a separate rifle bar is dispensed with and the rotating parts are confined to the front end of the tool.

A unique rotation device is employed in the Hummer drill. A section through the drill is shown in Fig. 14. In this machine the ordinary methods of rotation have been superseded by a method which is independent of the movements of the piston. The air is first admitted into a small rotary motor M located at the back head of the drill. The rotation of this motor is transmitted through the worm gearing W, the shaft S and the spur gearing G, to the drill shank. Roller bearings are employed to reduce the friction to a minimum. The advantages claimed for this independent form of rotation are: (1) great smoothness of operation, (2) the free movement of the piston produces greater drilling speed and operation under very low pressure, (3) absence of expensive fluted pistons, rifle bars, and ratchet, with lower cost of repairs. As against these

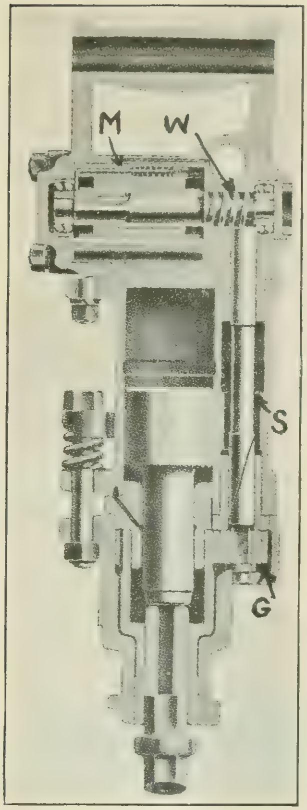


Fig. 14. The Rotation Device of the Hummer Drill.

it must be remembered that the necessary shafting and gearing is a complication and a possible source of weakness.

In the hammer-drill specially designed for stoping and having automatic air feed the rotation of the drill steel is accomplished by hand. A lever or handle is provided on the drill for the purpose. The handle is used in the manner of a ratchet brace, being swung alternately backwards and forwards as the work of drilling proceeds.

Support.—Except in the case of the smaller sizes of the hammer type, rock-drills require to be fixed to some form of support. A common arrangement in quarrying, sinking, and in situations where the general direction of the holes is downwards is to mount the drill on a tripod. The legs of the tripod are heavily weighted by detachable weights so as to resist the upward thrust on the drill. They are also separately adjustable in length and in inclination so that the tripod can easily accommodate itself to uneven ground, and a wide range of adaptability is obtained. Indeed, although probably best suited for downward holes the drill may be clamped to the tripod for any direction from downwards to vertical. The Lewis Hole tripod, made by the Sullivan Company, in addition to the regular features of the ordinary tripod, has a planed and slotted front bar which permits of a lateral movement of the drill. By this addition parallel holes can be drilled without resetting the tripod.

Another arrangement which is extremely convenient for many classes of work is to mount the drill on a column or bar. It consists of a strong cylindrical steel column with a screw at one end to permit of adjustment. Sometimes for the larger drills a double-screw column is used. The drill is carried in a clamp or saddle mounted on the column, and sometimes a double clamp with an extension arm is provided. The extension arm is particularly suitable for tunnelling or sinking operations, as it permits of the drill being mounted close to the side walls for drilling side or corner holes. The column is made in several lengths to suit different heights, as the jack-screw of course only allows a limited adjustment for length to be made. With a column the drill may be swung into any desired direction or moved into any position along the column.

For tunnelling and quarrying, drill carriages are sometimes used, while in shaft-sinking boring frames or platforms allowing simultaneous drilling over practically the whole shaft area have been employed. In quarrying work, where it is often impossible to fix a screw column in the ordinary way, recourse is often had to the support of the boring bar at its two extremities by means of weighted cross-legs.

In the automatic air-feed drill, the telescope is also made to serve for the support of the drill. The tube ends in a spike which is stuck into a piece of wood placed on the floor or other convenient part of the working. This type of machine is especially designed for work in the stopes.

Dust-Allaying.—Drilling, if carried out in the dry, must of necessity produce clouds of dust more or less fine. The operator of a rock-drill would, therefore, if no effective means were employed to allay the dust, inhale great quantities of it into his lungs. It has been found that some dusts, such as those of coal and shale, are not harmful, since after a time the dust begins to be ejected from the lungs. This is not so, however, with quartz and quartzite dusts. The finest portions of quartz dust remain in the lungs or only a small proportion of it is expelled. They thus block the minute air cells of the lungs and lacerate the finer tissues, causing silicosis and rendering the operator extremely susceptible to attacks by the tubercle bacillus, so that in bad cases death from phthisis supervenes. Several Royal Commissions have investigated this matter in South Africa and elsewhere in the British Empire and enactments have been made which render it obligatory to prevent dust-clouds.

Numerous devices have been tried to render the dust harmless, but only two may be said to have been completely successful. The first consists in sending a continuous stream of water down the hollow steel of the borer, and the other in spraying the mouth of the shot-hole with water. The first method is exemplified in the Leyner-Ingersoll drill, the Holman water-feed hammer-drill, the Hydromax hammer-drill of the Climax Company, and the Denver Dreadnaught drill. In these water is forced through a hole in the boring tool right to the face of the bore-hole. The advantages arising from this method in addition to the effective laying of the dust are: (1) the water effectively clears away the cuttings from the bottom of the hole and allows the bit to strike fresh rock at every blow, and (2) it cools the cutting edge and preserves it. In the Leyner and Holman drills both air and water are used. The water passes from the rear of the drill through a water-tube into the hollow steel. Here air from the drill mingles with it and both pass down the borer to the bottom of the hole. This is a very effective system and aids the work of the drill. In the Water Jack, Hydromax, Dreadnaught, and Sullivan drills, however, only water is used. In this method, as also with the Leyner drill, the water must be under a pressure of 30 to 50 lb. per sq. in. This pressure may be obtained from a pressure-water pipe or by employing a small closed cistern and using the compressed air which operates the drill to act as the pressure agent on the surface of the water in the cistern. Fig. 15 shows the Sullivan Hyspeed drill with water attachment.

In drills which operate dry either with solid borers or with hollow steel and an air flush, the water spray is employed to allay the dust. This is accomplished in a very simple manner. Referring to Fig. 16, the air enters at (*a*) and passes through the nozzle (*n*). Here its velocity increases enormously, and the resulting injector effect sucks water at (*w*) through a flexible hose from a tank or pail. The mingled air and water are ejected at the spray nozzle (*s*) in the form of a coarse spray which is directed at the mouth of the bore-hole. The spray, meeting the dust-cloud, effectively renders it innocuous. It is necessary that the water be correctly atomized. This is best done, as has been conclusively proved by experiment, by means of compressed air. The pressure air, in issuing from the jet, effectively separates the water into drops.

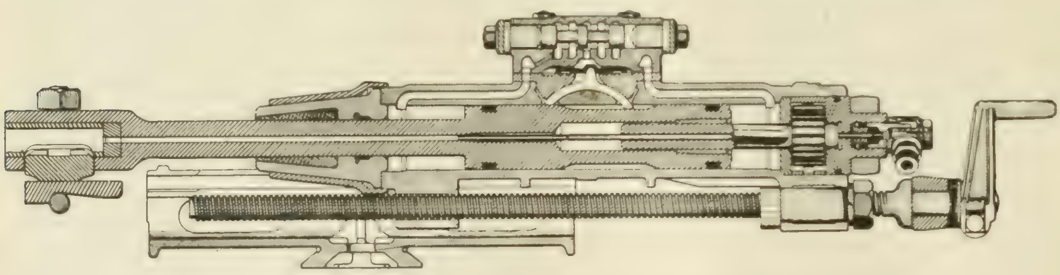


FIG. 15. THE WATER ATTACHMENT OF THE SULLIVAN HYSPEED DRILL.

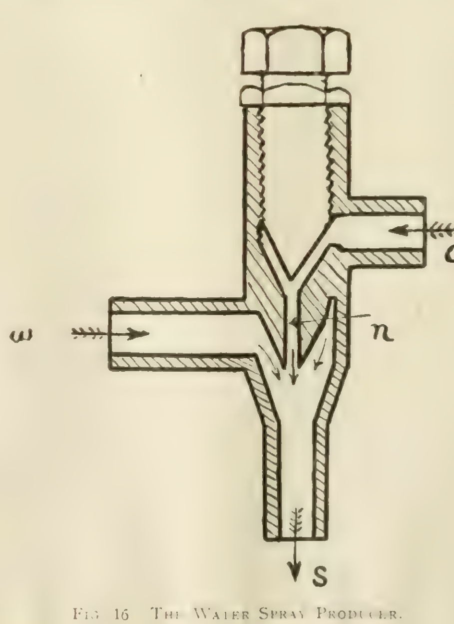


FIG. 16. THE WATER SPRAY PRODUCER.

The size of the jet and the proportion of water to air should be proportioned so that the correct degree of atomization is attained. If the atomizing is too fine a dense fog is created, and if it is too coarse large drops of water are formed which readily fall to the ground and do not effectively lay the dust. In drilling a coarser spray is permissible than in sprays which are used for laying dust in the roads, since the distance before deposition is much shorter. Indeed in the spraying of roads and working faces after blasting, in which operation needless to say a vast quantity of dust is produced, it is probable that the best method of laying the suspended dust is a combination of a very fine water spray followed shortly afterwards by a coarser jet.

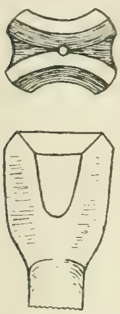


FIG. 17

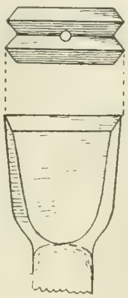


FIG. 18.

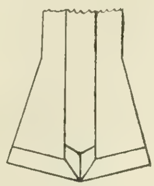


FIG. 19.

DRILL BITS.—It is not too much to say that the success of a rock-drill depends very largely on the proper shape of drill steel and on the skilful sharpening and tempering of the bit. The single chisel bit so much used in hand boring is apt to drill irregular holes when used with machine drills, and the double chisel cutter is generally better, as boring much rounder holes. Moreover the two-edged bit has the great advantage of protecting the central hole in the drill steel when air or water flushing is used to clear out the cuttings from the bottom of the hole. Several forms of two-edged bits are used. A common form is that having the two edges parallel; another has the two edges crossing at right angles; and still another like the letter X. The last is a favourite form of bit with many users of drills. The centre of the cross should be raised slightly, a suitable angle of slope being 20° (see Fig. 17). The convex shape tends to keep the drill bit central and to prevent the hole from diverging. A three-edged bit, having the edges shaped like the letter Z, is also much used, while the rosette bit, which has three cutting edges crossing each other on the diameters of a hexagon, is preferred for some purposes. The section of the steel is generally cylindrical, either plain or having a spiral, but octagonal and cruciform sections are also used. The function of the spiral is to act as a conveyor which draws the cuttings from the nose of the bit towards the mouth of the hole. It is most suitable for soft rock and for down-holes where there is a tendency for the debris to clog the bit.

Theoretically the best form of cutting edge is that which is so designed as to evenly distribute the work over its whole length. With such a bit in perfectly homogeneous ground the entire cutting edge would become dulled to the same extent. With no bit at present in use is this the case. In all of them the outer fringes of the cutting edge have to do the major portion of the work of drilling. In consequence it is the outer edges which wear most quickly. The contour of a cutting edge which would theoretically ensure equal wear over the whole of the bit would, however, be impracticable. Nevertheless, in designing drill bits this fact should be borne in mind. From this point of view the double-edged chisel bit is better than the cross-bit (see Fig. 18). An even nearer approach to the ideal is the double-arc bit recommended by the Sullivan Company (see Fig. 19).

For soft ground the angle of the cutting edge may be sharper than for drilling in hard ground. For hard rock the angle of cutting edge should not be less than 90°. The shoulders of the bit should be well supported for strength, and properly designed reaming edges are necessary to enable the bit to ream out the hole and maintain the gauge.

The difference in gauge of following drills should not be more than $\frac{1}{8}$ in., and some writers advocate as little as $\frac{1}{16}$ in. In hard rock, however, it is probable that at least $\frac{1}{8}$ in. is necessary to ensure the drills following each other easily. It should be remembered that the greater the reduction in gauge in the drills of a set the larger will be the initial diameter of the hole for a given final size. This means additional work the drill has to do for the same effective size of hole.

The steel from which the drills are made should contain from 0·6 to 0·85% carbon and be free from sulphur and phosphorus. The heating, whether in ordinary blacksmith forges or in oil, gasoline, or electric furnaces, should be properly regulated and the tempering done at the proper temperature. Sharpening is generally done by hand, but machine sharpeners are also largely used. A separate dolly should be used for each size of bit.

OPERATION OF DRILLS.—The success of a drill depends largely on the care and skill of the operator. The commencement of a hole is the most difficult part, especially if a hand hammer-drill is used. With the piston drill securely fixed to its tripod or column the starting of the hole is generally negotiated with comparative ease if care is taken to select a face of rock normal to the line of the drill. But with the hammer-drill, even allowing for equal care in the choice of the starting point, there is the necessity for holding the drill up to its work, with the consequent tendency for the bit to spread itself over an area much larger than the proper size of the hole. With screw feed machines the proper rate of feed to suit the particular ground should be the careful study of the drill-man. Too rapid feeding shortens the stroke and reduces the drilling capacity, and under-feeding will result in damage to drill shanks, and produce breakage of chucks since, if the bit is not up to the face of the rock, the whole force of the blow of the piston expends itself on the steel instead of on the rock. In feeding the bit should always be kept pressed lightly against the bottom of the drill hole. With hammer-drills care should be taken throughout the whole period of drilling that the drill steel and the machine are in line, otherwise the piston will not hit the steel fairly but on the edge, and may eventually injure the end of the hammer and chip the shank.

Drilling with blunt bits is bad for any machine, and sufficient sharpened bits should be at hand to replace a damaged or blunt steel when required. The blunter the bit, the greater the shock to the tool and the drill when the blow is struck. Breakages of drill shanks are largely due to drilling with blunt bits. Proper attention should be given to the lubrication of the valve. When inserting a borer which simply fits into the chuck, care should be taken not to force it in, as it may take hours to get it out, and the shank should not be passed by the smith before being gauged to make sure that it will fit into the chuck properly without being too tight. With drills using the U-bolt chuck, the latter must grip the steel securely and in true alignment with the piston extension. The chuck bushing should be renewed when too much worn. It is one of the most important parts of the drill, as if it is much worn it interferes with the correct alignment of the steel. If the shanks of the drills become excessively worn, they should be re-shanked, as ill-fitting shanks are a second source of incorrect alignment. With a new or newly-sharpened bit, the air pressure should be turned on gradually, gently at first, and then afterwards gradually increasing to full pressure. This caution may avoid breaking the corners of the bit. Before coupling up the air-hose to the machine it is a good plan to blow air through it for a few seconds, and on disconnecting the hose from the machine the inlet of the latter should be plugged. In this way dust and grit will be prevented from getting into the drill. With drills which have a water-feed through the steel to the bottom of the bore-hole, the water should be turned on *after* the air and turned off *before* the air.

When the drill is not in use it should be laid in as clean a place as can be got and not just laid down anywhere. No drill, however well-designed or strongly-made, can continue to give satisfaction for an indefinite time unless it is properly looked after and overhauled from time to time. In examining and refitting, particular attention should be given to the valve, the rotation gear, and the piston. Damaged or badly worn parts should be replaced. If the piston should become too slack in its cylinder, the latter should be re-ground and a new piston fitted. In general this should be done when the diameter of the piston is less than the bore of the cylinder to the extent of more than $\frac{1}{64}$ in. Some makers supply pistons increasing by $\frac{1}{16}$ in. diameter, and when a cylinder has become worn it may be re-bored to fit a piston $\frac{1}{16}$ in. larger than the piston previously used. Some users of drills, however, prefer to purchase new cylinders rather than bore out worn ones. If a cylinder is much worn there is no doubt that the loss through increased air-consumption of the drill will in a few weeks equal the cost of a new cylinder. An innovation introduced by the Sullivan Company in 1913 in their Liteweight drill consists in the use of a cylinder fitted with a renewable liner of hardened steel.

Rockers, tappets, and auxiliary valves should be frequently inspected. Excessive or irregular wear has the effect of shortening the valve movement, producing cushioning of the blow of the drill. The feed-screw and feed nuts in piston and cradle hammer-drills should be kept in order and replaced when worn. Careful attention should also be given to the cradle of the machine. If the cradle guides become greatly worn the machine loses in rigidity so that the drill bit does not hit true, but strikes a different place in successive blows. This undesirable feature will be most apparent when the machine is run out to the full extent of the feed screw. Whenever instability of the machine is noticeable, inspection of the cradle or of the clamp, arms, or bar to which the machine is fixed should be made and the matter put right without delay. All cradle machines have provision for taking up wear in the cradle guides.

All drills should be brought to the surface for inspection and repair periodically, say every three months. A record should be kept of the condition of each drill at each inspection and the details of the repairs carried out. The importance of maintaining the drill in a high state of efficiency cannot be over-estimated. No type of drill, however good in design and construction, will continue to produce satisfactory results unless it is carefully, skilfully, and systematically overhauled and all the parts maintained in as perfect condition as possible. As one writer on the subject has said, the key to success in rock-drilling may be summed up in the word "maintenance."

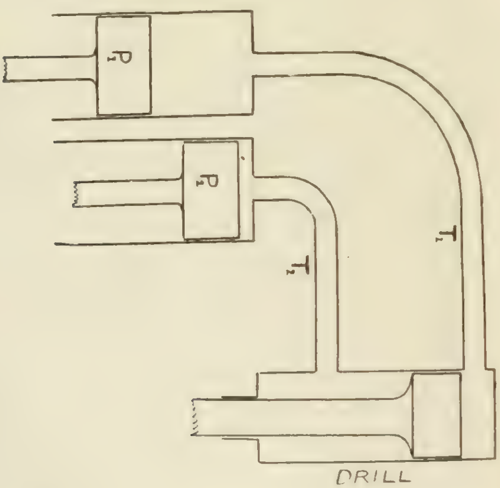
AIR PIPING AND HOSE.—The compressed-air main should be designed to give a low pressure drop, say 3 lb. per 1,000 yards. Branch pipes may be allowed a greater pressure loss, anything from 3 lb. per 300 yards to 3 lb. per 100 yards. Great care has to be taken in maintaining the pipes against leakage. Joints should be frequently inspected and leakages prevented. Stop-cocks are a frequent source of leakage. Gland packings should be renewed from time to time and whenever there is any sign of leakage. The faces of the valve should be ground to a perfect fit whenever there is appreciable sign of wear. The air-hose should be of the best quality obtainable. Cheap inferior hose is uneconomical and soon ceases to be air-tight when subjected to the rough usage inseparable from underground conditions. The size of the hose should not be less than $\frac{3}{4}$ in. diameter, and for the larger development drills preferably $\frac{7}{8}$ in. or even 1 in. diameter.

Armoured hose has a longer life than unarmoured. The armouring, consisting of galvanized iron wire, round, half-round, or flat, protects the hose against abrasion, prevents flattening, and eliminates the risk of the hose being squashed flat or injured by being bent to too sharp a radius.

THE ELECTRIC DRILL.—The use of electricity as a motive power has developed to an enormous extent in mining during the last twenty years or so. It has been applied with great success to practically every form of mining work. The operation of drilling, however, presented peculiar obstacles. There was first of all the fact that the natural motion of an electric machine was rotary. Thus to obtain percussive action, which in hard rock is attended with much better results than grinding, it appeared to be necessary to convert from the rotary to the reciprocating motion. This change involved complication of parts, many of which were necessarily weak unless the appliance was to be prohibitive in size and weight. Nevertheless, machines, of which the Gardner and the Siemens drills are examples, have been constructed. In the Gardner drill the motor, mounted on a bogie, gave motion through a flexible shaft and bevel gearing to a cross-head and crank which imparted a to-and-fro movement to the drill steel. The drill was rotated after each blow by means of two ratchet wheels, and had the ordinary screw feed. In order to obtain a quick forward blow the crank was made to work in a specially shaped slot in the cross-head so that the blow was struck in a quarter of a revolution of the crank-shaft. A fly-wheel was used which absorbed energy during the portion of the stroke when the drill remained stationary and gave it out on the cutting stroke. In the Locke electric drill the motor was mounted on the drill itself and the crank axle driven direct through gearing. The vibration in this arrangement tended to rupture the insulation of the motor, and caused the brushes to kick on the commutator if a direct-current motor was used. Other drills which have been tried are the Adams, Deitz, and Durkee.

The solenoid principle has also been utilized to produce a workable electric drill. Indeed it was one of the first ideas to be employed. The Marvin-Sandycroft and Edison drills were of this class. In these, two coils of wire or solenoids were made to reciprocate a soft steel piston. Two-phase current was used and each coil was energized alternately every half-revolution. Rotation of the piston and drill tool was accomplished in the manner common to the ordinary air-operated drill. The disadvantages of this form of drill are: (1) the heating losses in the solenoids, (2) the great weight of the drill, (3) low drilling speed, (4) unreliability. The chief drawbacks of the crank-driven drill which, however, has attained greater success than those designed on the solenoid principle, are: (1) the weakness of the flexible or telescopic shafts used, (2) the clumsiness and complication of parts, (3) the low drilling speed, and (4) inability to stand the rough usage which is almost unavoidable in mining. Summing the matter up in a few words one might say that the electric reciprocating drill which will prove a serious competitor with the air drill has yet to be invented. In the opinion of many mining men who have had long experience of machine-drilling, the rapid development of the light hammer-drill has made it unlikely that the electric drill will ever displace compressed air for this class of work.

The electric rotary drill is, however, quite a different matter. Here there can be secured lightness, compactness, and simplicity of parts. The scope of the drill is of course limited to coal and soft rock, but for these purposes it has proved eminently successful. The rotary machine driven by electricity is more compact and more efficient than the same machine operated by compressed air, and for this class of drill it is only in situations where there are risks from explosive gas or dust that the air-driven machine is to be preferred.



G. 20. DIAGRAM EXPLAINING ACTION OF THE TEMPLE-INGERSOLL ELECTRIC-AIR DRILL.

The most successful application of electricity to the operation of a rock-drill is to be found in the Temple-Ingersoll electric-air machine. Here a combination of electricity and compressed air is employed. The actual drilling agent is compressed air, but the energy is stored in the latter by an electric motor operating an air-compressor, or rather pulsator, in close communication with the drill proper. In this way it has been possible to combine the great flexibility, economy, and efficiency of the electric current as a motive power with the well-known successful application of air to rock-drilling. The principle of action of the drill will be understood from the diagram (Fig. 20). The two pulsator pistons P_1 and P_2 are actuated from cranks on the motor shaft. The cylinders are connected to the drill cylinder by the two flexible tubes T_1 and T_2. The whole of the space between the pulsator pistons and the drill piston is filled with air at a low pressure. On the up-stroke of P_1 the air in that cylinder is compressed and the drill piston forced forward on the hitting stroke. This action is aided by the other pulsator piston which during this interval is on its suction stroke. On the back stroke of the drill, P_2 is compressing and P_1 sucking. The air is never exhausted but is used over and over again in the closed circuit. Should leakage of air occur, a compensating valve opens when the pressure falls below a pre-determined limit and admits free air from the atmosphere which is compressed by a differential area on one of the pulsator pistons until the normal working pressure is restored. The drill is extremely economical and where the conditions suit is very successful, as for striking power and mudding qualities it compares favourably with the ordinary drill. It is not suitable for ordinary stoping work because of the cumbersome nature of the motor and pulsator, which is generally mounted on a bogie. But for tunnelling, level-driving, and quarrying work it is eminently suitable.

TESTS AND EFFICIENCY.—The success of a rock-drill depends upon the following points in order of importance: (1) speed of cutting, (2) strength and durability, (3) air consumption, (4) portability, (5) ease of fitting up, (6) simplicity of construction, (7) ease of repair.

From the points of view of portability and ease of fitting up, the hammer-drill of course has a great advantage over the heavy piston-drill, but the two classes have really to be considered separately, as each is to some extent supreme in its own special sphere of work.

A high speed of drilling is a strong point in favour of a rock-drill, but that alone is not sufficient to make the machine a success. Nothing could emphasize this more pointedly than the competition arranged in 1907 under the auspices of the *South African Mining Journal* to test the merits of light stoping drills. The machine which outdistanced all others from the point of view of cutting speed was the Gordon, a hammer-drill. Yet when put to actual use underground it could not stand the wear and tear of everyday work, and failed to come up to the expectations warranted by its position in the tests. The test clearly proved that high cutting speed, though greatly to be desired, must also be accompanied by reliability or else the machine is doomed to prove a failure.

It should be remembered, too, that the cutting speed in any given rock material depends very largely on the skill of the operator, the state of the drill as regards repairs, the efficiency of the drill bit, and the effectiveness with which the bottom of the drill hole is kept clear of the cuttings made by the drill. Further, the air-pressure used has an important bearing on the speed of drilling. A high air-pressure produces a more powerful blow for a given size of drill, but the drill bits are blunted more quickly, the machine itself is subjected to greater stresses, with the inevitable result that breakages occur more frequently, repairs are high, and the life of the drill is shortened. On the other hand, very low pressures are certain to prove uneconomical, especially in hard rock. Air-pressures varying from 40 lb. per square inch up to 120 lb. per square inch are used. The best practice is to employ pressures of 60 to 80 lb. per square inch, and to maintain the working pressure as uniform as possible.

The speed of drilling has increased considerably of late years, and it would be safe to say that the average cutting speed has been doubled in the last ten years. But what is of more importance, the reliability and handiness of the machines have been enormously improved. There is no doubt that much of this advancement is due to the enterprise of manufacturers as well as to the insistence of the user on a drill that will stand the rough handling of underground conditions.

Perhaps the most complete series of tests of rock-drills carried out in the history of mining were those conducted by the Transvaal Government and the Chamber of Mines in 1909–10. The tests were carried out under ordinary underground conditions, and their exhaustiveness can be realized from the fact that they stipulated for 300 drilling shifts in seven different stopes. The test period was, however, eventually reduced to 215 shifts of eight hours each, owing chiefly to it being found impossible to maintain the requisite air pressure in one of the mines where the drills were to be tested. Twenty-three drills entered for the trials, and nineteen of these started the competition. Only four completed the test, these being two Holman drills, the Siskol, and the Chersen. The prizes were £4,000 for the drill taking first place and £1,000 for the second best. The Holman and the Siskol drills were deemed of equal merit and the prize money was divided between them. The total cost of the competition was over £17,000, but there can be no doubt about the great value of it, since ordinary working conditions prevailed throughout, and the duration of the test was such as to test the durability and reliability of the machines severely. Elaborate records were kept of footage drilled, costs for labour, drills, sharpening, spares, and stores, air-consumption, etc. All the four drills completing the test were reciprocating drills, an altogether different result from the 1907 tests already referred to when a hammer-drill was the best. The winning drills were light machines, the weight being limited to 100 lb., and the competition being intended for stoping drills. Experience in the tests and since has shown, however, that a slightly heavier machine can be conveniently handled in the stopes and a more powerful drill obtained. About 130 lb. is now considered to be the best weight for a stoping drill of the piston type.

The air-consumption of a drill is a matter of of great importance. Not that it is quite so important a factor as speed of cutting and durability. Nevertheless the air-efficiency of the drill must not be ignored. The compression of air is costly, and no machine operated by air-power can be tolerated which does not endeavour to use the air to the best advantage, consistent of course with the other necessary desiderata. During the South African tests the drills were periodically taken to the Johannesburg University Technical College where the air-consumption was tested. The air-consumption of a drill is usually expressed in cubic feet of free air per minute, that is, air at normal atmospheric pressure. The actual quantity of air measured in terms of free air taken by a drill depends upon: (*a*) the size of drill, (*b*) the air pressure, and (*c*) the condition of the drill. Naturally the larger the drill the greater the quantity of air taken. Also if the drill is in a state of disrepair it will take a much larger quantity of air to do the same work than if it were in good condition. As regards the air-pressure, the quantity of air taken by a given drill is not quite directly proportional to the working pressure. For example, a drill working at 100 lb. per square inch does not take twice as much air as the same machine working at 50 lb. per square inch, but only about 80% more air. The air-consumption of piston-drills in good condition varies from about 65 cu. ft. of free air per minute for a 2 in. drill at 70 lb. per square inch pressure to about 175 cu. ft. per minute for a $3\frac{1}{2}$ in. drill and 100 lb. per square inch pressure. Hammer-drills take anything from 50 to 100 cu. ft. per minute.

Most manufacturers and many mine-owners

test the efficiency of their drills from time to time. It is not a simple matter to measure the efficiency of a rock-drill. One can calculate with ease the horse-power represented by the compressed air the drill consumes, but it is a much more difficult problem to estimate the amount of useful work performed in the usual engineering units. As a matter of fact it is hardly possible to estimate the absolute efficiency of a rock-drill. All that one can do is to compare one drill with another. In order to carry out such a test fairly, the several drills should be in an equal state of repair, they should be operated by the same skilled drill-man or by men equally skilled in the working of their respective drills, the drill bits should be of the same class of steel, and shaped, sharpened, and tempered with equal care, the drilling should be carried out in the same kind of rock, and the air-pressure should be maintained uniform throughout the tests. Such tests, if carried out carefully and with scrupulous fairness, cannot fail to be productive of good results. They will show up the relative merits of the types of drills tried, both as regards cutting speed and air-consumption. It should not be forgotten of course that a drill is constantly being tested in the ordinary everyday work of drilling in the mine, and the testimony of the drill-runner or mine-foreman is one of the most valuable criteria of the worth of a drill.

FOUR YEARS AS A PRISONER OF WAR

By J. C. FARRANT.

(Continued from the July issue, page 33).

The Author continues his account of the treatment of English Prisoners of War by the Germans, describing conditions under which they worked in the firing line in Russia.

March, 1917. We were all weak from hunger and long hours, and men used to stumble and sway about every night when returning to the lager, often turning in without undressing. One or two men had watches, and every few minutes someone or other would ask the time. I was glad I had no watch.

March 14. Returned to lager 4 a.m, coughed continuously till 7 a.m.; got up at 8 a.m., and saw doctor, who gave me some tablets and ordered me to work; turned in from 10 a.m. till 2 p.m. Started for another night shift at 4 p.m.; came back to lager 12 hours later absolutely knocked.

March 16. Observation balloon spotted us going to work. Russians shelled us all the way up to the trenches, but no casualties. It was warmer, and the artillery was more active on both sides.

March 17. The most bitter night I have ever experienced, temperature at zero, with strong wind. Men complained about thinness of the soup. The Lieutenant went into a rage, and told us we were getting all we were allowed.

March 18. Sunday. Reached lager exhausted. Temperature below zero, and blizzard part of the day. Couldn't keep warm, although we had a fire in our dug-out.

March 19. Paraded 7 a.m., clearing snow till 8 a.m., then marched for two hours in deep snow to new position. Worked till 4 p.m. with no stand easy, two hours walk back. Done up, drank soup, and turned in.

"I don't know how much longer I can stick it; my strength has just about given out, but I can still smoke."

March 20. Felling trees in 2 ft. of snow. Swapped some soap for bread with German soldier. We carried on with this work for a week, and of all the Germans I have met there is one who stands out as a white man in his treatment of prisoners of war; he is the N.C.O. in charge of the wood party. He offered us the remainder of his soup which was brought out to him daily, and believe me it wasn't offered in vain.

At this time I was physically incapable of using an axe for felling, but I could use the saw which was much easier work. A German pioneer did the axe work.

The bread ration yielded 5 thin slices about ½ in. thick by 4 in. square. The methods of apportioning these slices varied. Some ate two slices for breakfast, and had three at night. Others one for breakfast, one for lunch, and three at night. While a third group, of which I was one, had one for breakfast, three for lunch, and one at night. This latter method helped a man to keep going by day, but often prevented him from sleeping owing to the knawing pangs of hunger. Often being unable to sleep I have pulled my next day's ration from under my jumper, and taken a mouthful when I turned in. The hardest thing in the world was to put it away again.

Those men who had plenty of soap were enabled to get bread from the soldiers. At first it was a ½ lb. cake of soap for a loaf of bread, but competition soon knocked that. More than one man has eaten a whole 3 lb. loaf right off after having swapped it for soap, and in each case was bad after it. Trading with the soldiers or guards was strictly forbidden, but of course it was done while the soap lasted.

The veneer of civilization was wearing off rapidly. Men seldom spoke; when they did, it was always about food.

A man was exchanging a piece of soap for a piece of bread one day, but another fellow pulled out a larger piece of soap and walked up to the German and got the bread. The second man was "birded" by the party, but little he cared, it was every man for himself. "Dieu et mon Droit," which translated into navy speech is "To hell with you Jack, I'm alright," was practiced on all sides.

March 30. Our party on returning to lager were searched again for diaries. While we were at work the Germans had gone through our kit bags. Several men missed soap from their kit bags. My diaries were in the toe of my sleeping bag, and it was on this occasion I almost decided to destroy my notes, as some of the men had been knocked about all day owing to C's diary being found, and naturally our own men were pretty sore. 25% sick, mostly of frost bite and general weakness.

April 2. My birthday. I celebrated it by having half an extra slice of bread, which meant this much less for the next day.

We were officially informed on parade that we should receive no parcels at all while we were here. The result of this news was rather unexpected, inasmuch as there was less "cribbing." Men felt that they had got down to bedrock and couldn't go any further, and that the only thing to do was to stick it.

April 5. Two more men dropped at work.

April 6. Four men dropped and were taken back to lager.

April 10. Men swapping underclothes and jerseys for bread. Some rotten fish was thrown out from the German cook-house. Some of the men ate it, and were violently sick later.

Occasionally soup bones, which had been boiled up in the cooker for the Germans, were thrown out. They were bare of meat, but we used to boil them over again and drink the water, crack the bones, eat the marrow, and chew the spongy portions of the bones.

We were occasionally able to obtain chewing tobacco from the soldiers in exchange for soap or money.

April 12. Russians and Germans started fraternizing, exchanging bread for cigarettes over the barbed wire.

April 15. We were disinfected; that is, our blankets were put into a disinfector and we had a bath. There were nearly 100 of us and there were six tubs. As one man followed another, half a pailful of warm water was added. No water was run off, so the bath was not all that it might have been for those who went last.

It was when we were in the bath house (in the German quarters) that men realized the privations they had suffered. We were like skeletons; shoulder bones, hip bones, knees, and elbows were horribly prominent.

April 16. 31% sick. New routine, rise 4 a.m., coffee 4.30, leave lager 5.35, return to lager 6.30 to 7 p.m. One hour's rest only was allowed between these hours.

April 17. Received letters from home; the first for two months. We were paraded and informed that France had withdrawn the German prisoners of war from the firing line, but that England had not.

April 20. Parcels arrived. The next day each man received a parcel after returning from work. The parcels were then deposited on the parade ground for inspection. The German Lieutenant ordered men to open tins in order to view the contents. No one slept that night, the excitement was too great. Some ate half the contents of their parcel the same night. Many were up at 3 a.m. cooking burgoo for breakfast.

April 22. Sunday, no work and a lovely day. A food parcel had already been issued, and today each man drew tobacco or cigarettes. Men said "Good morning" to each other. Some even whistled and sung, the first exhibition of pleasure that had ever taken place in this cursed spot. This was the happiest day I ever spent as a prisoner of war. We were men again. It was great, and all on account of a little extra food.

During the past two months, many men who had "messed in" since they were captured, parted on this "spasm."

The division of the bread ration was a matter of vital interest. There is only one fair way, and it is this: The loaf or loaves are cut into portions, every man taking an eager interest in the cutting. Then one man turns his back, and as the cutter indicates a certain portion, the man with his back to the bread calls out a man's name, the man named taking the portion indicated, and so on. The same method was applied to the jam issue, which ran out at a dessert-spoonful for two days per man.

April 30. The Jaeger Co. No. 151, who were mostly Saxons and had been in charge of us from the beginning, were relieved by a company of Prussians who were not fit for active service. The first day with the Prussians was the reverse of pleasant. We were employed in shovelling mud on to the corduroy roads. It rained all day long, and we were wet through by 11 o'clock, when the second guard took us over. We worked through till 5.30 p.m.

May 3. Bread ration reduced to three slices a day. Young, of the R.N.D., died. He had been excused duty, but was not admitted to hospital. He died in the dug-out.

The cold weather was now breaking up, snowing and fine alternately; we were beginning to feel the beneficial effect of the extra food that came in the parcels, as on May 19 there was only 4% sick other than those with frost bite. Heavy artillery became more active on both sides, though there was no rifle fire. At the end of May, before the snow had melted, the mosquitoes became very bad, for we were right in the swamps which lie southwest of Riga.

May 26. Every man was compelled to sign his "death warrant" as the boys called it. The duly signed sabotage paper looked more like a Chinese puzzle than anything else, as few of the signatures were legible.

June 1. Russian and German aeroplanes were getting busy, though we didn't see one brought down on either side. The work now was a "gaff." The new guards, who were very fed up with war, didn't bother us, so we took things easily.

June 10. Received orders to move.

June 12. Arrived at Libau. The reprisal was over. At Libau we met some of the 500 men who had been previously sent to Mitau. They had had a great deal more sickness than us, and a much larger number in proportion were in hospital. Several men of this company died from starvation and cold. After a week's rest our company and some of the other reprisal company moved to another lager in Libau, to work on the docks. The rest of the camp was sent on kommando.

From now on we carried on as other companies had done in Libau, as has already been described. Each man more or less had his special "donkey," whom he saw at the docks every day. The hurried scraps of daily conversation were in many cases supplemented by letters written in German at night and exchanged on the following day. Some men wrote their own love letters, while others obtained the assistance of those who could "speak the bat." My services were occasionally requisitioned. On one occasion a big North Sea fisherman from Stornoway told me his "donkey" wouldn't speak to him because she had seen him yarning with another girl, and would I write a letter for him. So I told him to leave it to me. It took two hours to write that letter and I handed it to him the same night. Being Scotch, he wanted me to translate it to him, so I read him out the more prosaic passages and away he went. If that "donkey" upon reading the letter didn't think she was the best looking girl in Kurland then it was because the dictionary I used wasn't big enough. The next night Mac said "It's alright," so I asked him if he had any chocolate to spare; he just grinned.

Everyone worked six and a half days a week, and on Sunday afternoons we generally played football.

June 30. Went with a party to the "Fischerei," humping sacks of dried fish about. Some of the girls employed at the Fischerei were not more than 12 years old. In the cleaning room there was a raised gangway upon which the fish cars were run, the contents being dumped into boxes on either side where the girls were working. A German unteroffizier, foreman of the cleaning room, took his stand on the gangway with a whip in his hand, giving a striking picture of German kultur in conquered territory.

July 23. Received balance of money sent from home ten months ago. Employed in lager, writing signs.

August 4. The following was given out on parade by the German unteroffizier in charge: "Your parcels will be stopped for 14 days because you have been guilty of giving biscuits and bread to the Lettish civilians." The "Lettish civilians" were children who begged biscuits from our men when going to the docks and returning to lager.

August 25. Given out on parade by dolmetcher Michaelis, nephew of the German Chancellor, that an exchange of prisoners of war would take place shortly.

August 31. One of our men was caught taking some sugar, with the result that the football match scheduled for that afternoon was stopped. This is typical of the German system of punishment.

September 26. Another shooting spasm in lager. Our men had been unloading rum, and by four o'clock many were down and out, and many of the rest were seeing red. The German in charge of the lager was requested by the dock authorities to come down and restore order. When he appeared at the dock some of the men made a rush to throw him into the river and were only restrained by the cooler members of the party. The whole party was ordered to return to lager. Some were helped, some were carried, and others came in carts and were deposited on the ground inside the lager gates, where they remained until some of their "school" claimed them. Some of those who were still under the influence of liquor tried to get over the wall, so the guards started firing, but fortunately no one was hit. There was no punishment on this occasion, as prisoners of war were not officially allowed to handle rum, so the German in charge daren't report the matter. There were the usual scraps, and the usual resolutions on the following morning of "never again."

November 2. Left Libau for Dantzig, by steamer or rather cattle boat. Arrived at Dantzig on the 4th, entrained, and reached Czersk on the 5th. The lager here had a holding capacity of 100,000 and had been used as a distributing lager for Russians. It was a rotten hole; rows and rows of dug-outs with a narrow gangway in the centre, with two sleeping shelves on either side. It was not possible to sit upright on the lower shelf. There was the usual rush for places, but we settled down by midday and then started "drumming up" outside the huts.

After a meal I was walking round the lager with another fellow. He had just remarked that there weren't many walking about, when two guards came up ordered us into the barracks. We turned in the direction of the barracks, and carried on with our conversation, when without any warning I got a bang in the back from a butt end. I turned round and just dodged a jab from a bayonet. I could see something was up, so I made toward the barracks and ran into six or eight guards coming round the hospital. The two who had first spoken were still following me, so there was nothing for it but to run the gauntlet. I was pretty quick, but those butt ends were quicker and I received a good drubbing before I reached the first dug-out. After I recovered my breath I asked what the trouble was, and I was told that earlier in the afternoon one of the guards had kicked over a can of water which one of our men was just drumming up, so the fellow let the guard have the remainder in his face, and then made a dive for the nearest dug-out. The guard had reported the matter, with the result that all the guard was turned out and an order was given that all British prisoners of war were to remain in the dug-outs. This order was unknown to many men, and of those who were walking about, many were manhandled, some of them having to go to hospital for medical attention. This matter was reported to the German C.O. on the following morning.

November 8. Seventeen hundred of us paraded for general inspection. The inspecting general said: "They are a fine-looking group of men: why are they here?" The German doctor, who had examined us on the previous day, replied: "These men have been on punishment kommandos in Russia, and they are all a bischen verrückt, a little mad; they will be sent into Germany." We remained in this lager about three weeks, during which time, as no fuel was supplied, we burned most of the bed boards in our own dug-outs and smashed up beds in empty dug-outs. No guards came inside the lager. We had never had so little supervision. We played football on the parade ground and quite a number of windows went west. One evening, however, an officer accompanied by several guards visited each dug-out and made notes. This gave rise to all kinds of rumours. The next day we were paraded and marched inside a barbed-wire enclosure. We were then told we should remain until the damage had been paid for. It worked out at 2 or 3 marks a head. The amount was finally collected, as every man felt he had had his money's worth.

During our stay here the deaths among the Russians ran from 10 to 15 a day. A huge burial ground lay just outside the lager, and every day parties bearing coffins could be seen marching to the burial ground.

November 27. A blizzard, with snow blowing in through the cracks. The narrow gangway was soon ankle-deep in mud. We didn't get much sleep that night. This weather kept on for three days.

November 30. Left Czersk for Chemnitz in Saxony. Before we entrained, we were warned that we must give up all knives. A dolmetcher and guards came round to each hut, searched us, and took all our knives, or thought they did. They said the knives would be given back to us when we reached our destination. The lager authorities undoubtedly believed we weren't quite "all there," owing to the horseplay and skylarking that went on during our three weeks' stay at this camp. Hence the order that all knives should be given up.

December 3. Arrived at Dresden, where we were again disinfected. We entrained the same night, and reached our destination, Chemnitz, on the next morning. We marched about $1\frac{1}{2}$ miles to the camp, packing all our gear with us. The rest of the day was spent in giving in our names and regiments, family history, whether we had "done cells" while in Germany or Russia, and what trade or profession we followed in civvy life, etc. Some of the trades and professions given in are worth repeating: hangman, doll's eye-brow painter, tea-taster, barman, and provision dealers by the score; mechanics were generally farmers, and so on; the majority of the men were regulars and just gave in "soldier." We were then detailed to different barracks, which were in reality stables. Our lager was situated in the artillery barracks, which were built entirely of concrete, as were the stables. I slept on a wood-wool mattress that night, the first mattress for a year. This lager had about 20,000 men on its books, of many nationalities, all of whom were out on kommando except a few who did the clerical work for each company. Our company, which was composed of British, was 1,700 strong. I was lucky enough to get on the staff as a writer.

During December as many men as possible were drafted to kommandos. The first batches to go went to surface coal works and to the pits, factories, road work, and later to farms. Englishmen were only sent to farms when they could send no one else, because it was far easier and more congenial work, though the hours were long.

This was a rotten camp as far as "drumming up" went. There was no wood to buy, borrow, or steal, and no hot water was issued for making tea. The buildings were heated by hot water, which was turned on for ten minutes every two or three hours. The men used to form up in ranks with their billies at the discharge pipes, having to wait an hour sometimes, and then the water would cease as some unfortunate man had his can underneath the pipe.

December 10. Parcels were about finished up, also tobacco, and we were once more up against the bête noire of gefang life, hunger. The soup was thin and unsatisfying. The daily ration was $\frac{1}{8}$th of a loaf, the only solid food. Men with money were offering high prices to Frenchmen for biscuits, the general price being two for 1 mark. The absence of tobacco and cigarettes was hell.

December 17. I gave a man 5 marks for $\frac{3}{4}$ oz. of tobacco, and thought I was lucky.

December 23. The French Help Committee decided to hand over to British N.C.O.'s 35 biscuits for each Britisher in lager for Christmas. The distribution was made that night, and several men had none left by the following night.

December 24. Men returning from kommando had all personal kit taken from them if it exceeded one extra shirt. Complaints were made to the commandant without success.

December 25. Christmas day in the home of Christmas festivities, Saxony. No parcels and no extra soup. The latter consisted of mangel-wurzel, potato peelings, and minute shreds of horse-flesh. The electric light went out between 5.30 and 8 p.m., and that's how Christmas, 1917, was spent with our so-called cousins.

December 26. One of our men who didn't smoke came round to where a bunch of us were sitting, and offered a tin of Capstan for 40 marks. Jerry Newland, one of our group, said: "Is he an Englishman?" Some one replied "Yes." "Well!" said Jerry, "I wish I'd been born a Chinaman." The man who offered the tobacco eventually raffled it at 1 mark a time, and I won it. One's feelings on such an occasion pass all description.

December 28. "Parcels up." The words went round like wild-fire, and with one accord men rushed up to the parcel office. Nearly every man drew at least one parcel, and it was a contented bunch of men that turned in that night.

December 31. Snowing and cold. Men waiting at the steam pipes throughout the day to "wet their tea."

(To be continued.)

The Institute of Metals.

The autumn meeting of the Institute of Metals will be held at Sheffield on September 24 and 25, Professor H. C. H. Carpenter, professor of metallurgy in the Royal School of Mines, presiding. The papers to be read are as follows: Moulding Sands for Non-Ferrous Foundry Work, by Professor P. G. H. Boswell; The Solidification of Metals from the Liquid State, by Professor C. H. Desch; Observations on a Typical Bearing Metal, by Miss H. E. Fry and Dr. W. Rosenhain; Season Cracking in Brass, by Dr. W. H. Hatfield and G. L. Thirkell; Ternary Alloys of Tin, Antimony, and Arsenic, by Dr. J. E. Stead; Graphite and Oxide Inclusions in Nickel-Silver, by Dr. F. C. Thompson; Constitution and Metallurgy of Britannia Metal, by Dr. F. C. Thompson and F. Orme; Early History of Electro-Silver Plating, by R. E. Leader; Properties of Standard or Sterling Silver, with Notes on its Manufacture, by E. H. Smith and H. Turner.

LETTERS TO THE EDITOR

Spitsbergen.

The Editor:

Sir—After reading two letters in your July number written by Rolf Marstrander and R. H. Blumental, of Norway, I request you will give me permission to reply.

Mr. Marstrander devotes himself mainly to attacking a publication issued by the Northern Exploration Company, and pins his own faith to "three iron experts, one Norwegian and two Swedish mining engineers of repute." Who are these three gentlemen who were "on the deposits from 1912 to 1916?" The Northern Exploration Company had its representatives working on the property in 1912, 1913, and 1914, but in 1915 and 1916 other work of more importance required British attention. It was then probably that the unnamed Swedish mining engineers took the opportunity to have a look round. It is a fact that the Swedish flag was hoisted on a building belonging to the British company, but this was hauled down when it was found that the result of the war was going in our favour.

Mr. Marstrander makes a rather bold statement when he says "No one knows the mineral deposits of Spitsbergen better than the Norwegian geologists and mining engineers who for the last 13 years continuously and systematically have carried out the exploration of the entire west and north of Spitsbergen." Well, I have been conducting operations from 1905 to 1914, when war was declared. In 1911 one of my old workmen, and a good fellow too, Hans Norburg, of Tromso, led a Swedish expedition up to a place where he and I discovered coal in 1906. I called on the Swedes and protested against their trespass and warned them that whatever work they did was at their own risk. Later on, a director of the Northern Exploration Company met officials of the Swedish company, when an amicable arrangement was come to. It is at this place, our old 1906 discovery, where the Swedes are now working good coal, constructed a small railroad, pier, and put up a well-built township. I saw no mining engineers during all my experience who had a staff capable of sinking a 10 ft. hole, but an isolated geologist now and then came my way, though none was equipped to do anything in the way of mining.

The main work done by Norwegians in Spitsbergen from 1905 to 1910 was whaling, by various companies, during the few summer months, and trapping in the winter by a few isolated individuals. Certainly no serious development work of any kind whatever was attempted on land, except at a few places in Green Harbour. It was here that a few persons were squatting on property which was claimed by the American company who were then opening up a seam of coal in Advent Bay. There was not a solitary Norwegian camp, or a company, that was doing any real mining work in any part of Spitsbergen, except the few men in Green Harbour who were disputing the American claim. Later on a wireless station was built by Germans for the Norwegian Government at this place. But that was not mining; it probably had some other object in view.

It would be very interesting to know what year Mr. Marstrander visited Spitsbergen. I have not to my knowledge ever seen or heard of him. If he has explored the country, as his letter leads one to believe, perhaps he will be good enough to inform you where he attempted mining, the amount of cash expended in actual work, buildings erected, etc., and the length of time he pursued his quest? "Two summers" are not much in Spitsbergen. Still a great deal would depend on the staff of men with him; it may have been one of considerable strength. An answer to these points would elucidate matters. From all accounts and reports, it seems that most of the Norwegian development work in Spitsbergen took place while Britain was fighting Germany. Mr. Marstrander says: "In 1917 and 1918 three Norwegian geologists together with their topographical surveyors traversed every corner of the land surrounding Horn Sound." Was Mr. Marstrander with this party of "geologists and topographical surveyors"—quite a fine sounding outfit—when they "traversed every corner of the land surrounding Horn Sound?" Captain Cook a few years ago claimed he had discovered the North Pole. No one believes his story now.

It is quite evident that Mr. Marstrander is unfriendly to both Spitsbergen and the Northern Exploration Company. Why? Has he a reason? I ask these questions because I have often been "approached," and more than once been invited to visit Berlin by good people who were very eager to make me rich! I know the Germans wanted Spitsbergen possessions. They actually came with a man o' war to take Marble Island in 1911, but I told the captain he was six years too late, and gave him a part of Cross Bay. It was at this place they conducted all their Zeppelin experiments, and erected a wireless station to connect with the station they put up for the Norwegian

Government in Green Harbour, and from there to every other part of the world. I know also that the Germans had some Norwegians acting for them in attempting to obtain coal mines; in fact the Germans were very sweet on the country.

I must disagree with Mr. Marstrander in his attempt to belittle the Northern Exploration Company's wonderful marble deposit. It is the finest ornamental marble deposit in the world. There are to-day--unless taken away by exploring parties visiting the place while the war was on—solid blocks of beautiful ornamental stone weighing 20, 25, 30, 40, 50, and 60 tons, and these can be duplicated in any quantity, for there is enough marble to supply the world for all conceivable time. Another good feature of this extraordinary deposit is that there are a very large number of varieties, all of them handsome, and as Mr. Marstrander truthfully admits, "take a beautiful polish and have beautiful colours." It is a correct statement. Of course there are thousands of tons of worthless debris on this marble deposit of about 10 square miles, but for every hundredweight of rubble there is a million tons of solid stone. But the rubble is not valueless, as lime or calcium-carbide can be made of it.

In Norway, and in Scotland as well, there are granite quarries being worked for stone. Do the companies extract sound blocks of stone from the surface? I don't think so. The Northern Exploration Company's marble deposit in King's Bay is ornamental marble, and, therefore, like all other ornamental marble in every part of the world, is of a friable nature. In King's Bay we are only scratching the surface, but from the tests made by bores (some of them down 170 ft.) we have evidence to prove that solid blocks of marble will be obtainable. This will be at a less depth than either the Scottish or Norwegian quarries have to penetrate in order to get a block of solid granite.

I am very much inclined to believe that the "geologist and two Swedish mining engineers of repute" who went to have a look at the iron deposit saw only the pup, and not the mother. There might have been a great deal of snow about at the time of their visit, and the iron location is not a place to go picnicing. There are formations in the vicinity as described by Mr. Marstrander on other people's statements, but that is not the locality meant when the term "Iron Mountain" is used. There are mountain masses of magnetite iron, very high grade, and even if it fails to grip the geologist's compass, answers very well to the pick, drill, and dynamite, and after all that is the crucial test, when iron ore is wanted of a 68% grade. I am convinced that every word of the Chairman's statements will be more than verified by actual results, and that he was justified in making them. He had before him samples of the iron, marble, coal, and other minerals, and had questioned and cross-questioned hardy Sheffield colliery managers and iron workers, also Norwegian geologists and iron workers, and other men with a knowledge of minerals, all of whom had done actual work with pick and drill not merely for "two summers," but for a dozen summers, and as many long winters. There is a difference.

With regard to Mr. Blumental's letter, I must say that this gentleman appears to have an axe to grind. After a long doleful account of other people's statements, including Mr. Hoel's, that all discoveries so far, other than coal, are valueless, he winds up, "that there is a strong feeling here (Kristiania) that Norway has the first claim to Spitsbergen." A rather tall order, when British and American capital have done more to develop the land than all the rest of the world put together. Mr. Blumental is also misleading for although it is correct to state that "the largest and most valuable properties are held by Norwegian companies," (I presume he alludes to the Advent Bay colliery), he omits to mention the fact that this company was developed and opened up solely by American capital, with American engineers and English colliery managers, and that the property with all its equipment and machinery, and already in a producing stage, was sold to the Norwegians by the Americans. At this time the Norwegians did not develop the property at all, but simply took over the show from the American owners, and every ton of coal taken out by the Norwegians was done while we were at war.

We can go one better than a 100 years ago, for a great many Scottish whalers over 200 years ago made Spitsbergen their headquarters every summer, and, if reports are correct, many of the crews used to go up to what was the first American workings in 1905-6 in Advent Bay, the present Norwegian company's property, and carried coal down on their backs for their galley fires. England also has had a great number of expeditions, both in the olden time, and more recently. Indeed the charts used by captains of ships belonging to all nationalities were then, as most of them are now, the Admiralty charts printed in London. Men o'war flying the white ensign have made navigable most of the harbours now frequented by calling vessels, by their work in making soundings.

Norwegian labour is mostly employed in Spitsbergen. I have had many hundreds of Norwegians working for me, both summer and winter, and I find them very fine men indeed. They render service for the wages and food given, and it is a fair bargain to our mutual advantage. For many years there was not a soul working on the land in Bell Sound, Lowe Sound, Braganza Bay, Recherche Bay, Van Keulen's Bay, and King's Bay, except in my employ. I believe there are thousands of Norwegians serving in our mercantile marine, and give as great satisfaction in that branch as my workmen gave to me in opening up the mineral deposits in the early days. Although these sailors render such splendid service under our red ensign, I don't think any would claim that they were responsible for the finding of the ship, or guiding the vessel on its way; none, I feel sure, would claim it. Is it not exactly the same with regard to the mines? Supposing the Norwegian sailors refused to work under the English flag, it would not stop progress, for our vessels would sail the seas as of yore.

The strangeness of Mr. Blumental's letter to me is that he doesn't seem to have even visited the country he is so anxious to decry and belittle, and yet at the same time work in what he appears to wish for, that Spitsbergen should belong to Norway. Suppose Norway had it, and they had a fracas with some power similar to that we recently had. How long could Norway hold it? And again, what about rights of us pioneers who paved the way? I don't think we should relish having our properties confiscated. Will Mr. Blumental supply a few more figures, and state the number of tons of coal mined and exported from Spitsbergen before 1914 and after 1914, also the nature of the developments of the other companies during the same period? By this way we shall then be able to see who the actual workers on the land really were.

ERNEST MANSFIELD.

London, July 25.

[We publish the foregoing letter in fairness to those whom we have criticized. Mr. Mansfield, however, does not give the specific information relating to the iron ore deposit for which we called. We are aware of the value of the coal deposits, and described them in July, 1915. As regards the claim to the ownership of the islands, we quoted Sir Martin Conway's history of the dispute in March last.—EDITOR].

2—5

Diamond-Drilling.

The Editor:

Sir—Reference was made in your issue of April to a paper read before the North Wales Branch of the National Association of Colliery Managers by Mr. J. Walker Steele, entitled "Some Difficulties met with in Putting Down a Diamond Bore-hole Underground." I have read the report of this paper in the *Iron & Coal Trades Review* for March 7. As the conclusions arrived at are greatly in error, some comment in the form of an analysis of the paper may be of interest to the mining community.

It would appear that Mr. Steele, in penning the paper, was actuated by a sincere desire to add to existing knowledge as to the adaptability of boring machines to underground conditions, but the conclusions drawn from the work in question are clearly not correct. In fact, a careful perusal of the paper leads to the conclusion that this particular work was carried out with a remarkable display of ingenuity in overcoming trouble, coupled, however, with great want of skill in the actual drilling operations. This latter would seem to have been the chief cause of getting into trouble while boring. Had a fairly skilled man been in charge of the work, there is absolutely no doubt that the only trouble they would have encountered would have been that occasioned by the loss of water in the bore-hole. While it is always requisite that an ample supply of water passes through the diamond crown while it is at work, it is not always requisite that this water be returned to the collar of the bore. This, you will note, qualifies the diamond crown. Where a shot crown is working, then it is imperative that the water returns to the collar.

One of the things, in fact it is not too much to say that the outstanding thing, that impressed me more than any other in the account of this boring was that the drilling plant should have been so destitute of apparatus for the recovering of the rods after they had become unscrewed in the hole. Recovering tools such as Mr. Steele has illustrated his article with, though rather more perfect in design, are part of the regular equipment of the diamond-drills that have been working exclusively underground in Cornwall for the past three years. These machines are manufactured by the Sullivan Machinery Company, and as these recovering tools are always listed in their catalogues, it would seem to have been rather superfluous to have gone to the trouble of designing and making them at the work.

Mr. Steele states that frequent difficulties were encountered due to the fracturing of the ground by adjacent workings, as well as to the ground being full of small faults which interfered with the washing out of the bore-hole, these necessitating the use of bran or sawdust in order to get the hole tight and secure good washing out. Both of these materials are only used as a makeshift; the logical material to use in a case of this kind, apart from reaming and casing the hole, is cement. This material in addition to plugging the crevices and making the bore water-tight, also reinforces any weak portions and prevents them from caving while the drill is at work. The cement is just as easy to use as either bran or sawdust. It is true that it takes a little time to set, but it makes a permanent job, whereas bran and sawdust simply give temporary relief. That the cores should split perpendicularly is nothing exceptional in any core borings, and with the Sullivan diamond-drills this is overcome by the use of a Sullivan double core tube. The wedging that takes place from the splitting of the cores is almost always attributable to the mechanical action of the wash water, which causes the cores to open out and wedge themselves in the tube so that nothing remains but to withdraw the rods and clear out the tube. In the double core tube, the core is always protected from the action of the water, and the clearance in the inner tube that carries the core is only such as to allow the core to pass, thus preventing the opening of the cores to any appreciable extent, and, therefore, facilitating the progress of the drilling.

The losing of the diamonds in the bore-hole can only be attributable to faulty setting or careless running of the crown. As nothing is said as to the method in which the diamonds were set in the crowns, it is not possible to comment on this part of the trouble. I have to say, however, that in over nine thousand feet of underground drilling that has been carried out in Cornwall there has never been a diamond lost in a hole; in fact, there has never been a diamond come loose in the crowns. This was not attributable to the fact that there have been highly skilled workers in charge, for the writer has trained all of the men who are operating diamond-drills in Cornwall, and in two instances these men had but three months in which to become proficient in both the running of the drills and the setting of the diamonds. This should speak very highly for the simplicity, efficiency, and adaptability of the Sullivan diamond-drills to underground conditions.

I agree with Mr. Steele that it is always best to have a skilled man in charge of work of that kind, but with his conclusion that the shot-drill would have been a better machine to use, I cannot at all agree. In fact, I have to say, from a description of the ground bored, that I greatly doubt if he would ever have got a hole down with a shot machine. Had this method been adopted, every time they lost the water or struck a crevice in the bore it would have had to be filled up, as, where water will lose itself, so also will the shot. That shot-boring is fool-proof is rather wide of the mark.

In regard to the unscrewing of the rods while the hole was being chopped or sludged, (this latter term I take to mean the cleaning of the bottom of the bore-hole), Mr. Steele is of the opinion that had the borers had more experience so as to have been able to judge the necessary amount of percussion and the violence of each stroke, the trouble would not have arisen. This is altogether surmise, as it is immaterial how great or how small a blow is struck. If other precautions are not taken, the rods will unscrew. Any fitter knows that a succession of blows will loosen the most refractory screw joint, and it may be taken as a rule that the solidity of the line of drill rods while chopping does not depend upon the rapidity of percussion or violence of stroke but rather upon the assiduity with which a tightening process is carried out. The usual practice is to strike a few blows and then turn the rods with a wrench. This method has the advantage of filling a dual purpose in that, in addition to keeping the line of drill rods screwed together, it also keeps the detritus in the bottom of the bore stirred up and prevents it packing, thus enabling the pump to evacuate it with the least trouble. It will be seen that this process is very simple and requires no skill to accomplish.

I gather from Mr. Steele's paper that his endeavour was to throw as much light as possible on the possibility of adapting diamond-drilling to underground conditions. As a great part of my life has been spent in doing just such drilling, I trust that the foregoing remarks will be taken in the same light.

J. A. MAC VICAR.

Whitehaven, July 18.

Patents in relation to industry formed the subject of a conference held in connection with the British Science Products Exhibition at the Central Hall, Westminster, on July 31, when the Bill now before Parliament was discussed.

NEWS LETTERS

TORONTO.

July 11.

DAMAGE BY FOREST FIRES.—Owing to the extreme heat and drought there have been extensive forest fires in Northern Ontario, which at one time threatened the destruction of many of the mining properties. Fortunately the danger was averted at the more important camps by heavy rainstorms, which checked the progress of the flames. The principal loss sustained was at Boston Creek, where the mill of the Patricia Syndicate, valued at $75,000, and the mining plant of the Cotter were destroyed. Some damage to mining properties was also done in the West Shining Tree area. A compensating advantage in that district is that the fires have cleared off much of the vegetation, exposing large areas of bare rock and rendering prospecting easy.

PORCUPINE.—This district has not been exempt from the widespread feeling of labour unrest, which is unsettling the mining industry elsewhere, but so far no serious difficulties have resulted and a settlement satisfactory to both parties has apparently been arrived at. The miners asked for an increase of wages, but intimated that they would be equally well satisfied if a reduction in the high cost of living could be effected. The Hollinger and Dome Mines have undertaken to meet their views by the establishment of company stores, and it is reported that the employees of the latter company have already benefited, by a reduction in the cost of the necessaries of life of about 18%. As soon as their plans are fully matured the Hollinger promises to do even better than this in cutting down living expenses. The Dome is maintaining production at the rate of approximately $120,000 per month, or about half capacity, the mill-heads running a little higher than the average grade of the mine. Net profits are conservatively estimated at about $2 per ton. The McIntyre is cutting a station in the main shaft at the 1,200 ft. level. Ore for the mill is being extracted from the 1,135 ft. level, and the shaft will be sunk 175 ft. deeper. The mill is running at capacity, with an average extraction of $10 per ton. The Dome Lake is driving a long cross-cut for the development of a large ore-body indicated by diamond-drilling. The capacity of the mill has been brought up to 100 tons per day.

KIRKLAND LAKE.—Work on the leading mines has been completely stopped by a strike of miners which took place on June 12. Conferences between the miners and mine-owners have been held, but without result, and the great majority of the strikers have left the district. Some have gone prospecting, and others are working on undeveloped prospects or small properties in outlying districts. The mine managers have determined to remain closed down until overhead expenses, which they claim leave no margin for profit, can be considerably reduced. Active development is being pushed, however, on many of the newer properties, including the Ontario-Kirkland, where a 100 ton mill will shortly be installed, the Greene-Kirkland, the Young-Duncan, and the Kirkland Combine. The Lake Shore during May treated 1,750 tons of ore for a yield of $42,136, being an average of $24·08 per ton. At the Kirkland Lake, when closed down, a 15 ft. ore face was showing at the 600 ft. level with ore stated officially to average $55 per ton. A 3 ft. ore-body running parallel carries $28 per ton.

COBALT.—For some weeks the miners have been threatening to strike, but the final decision has from time to time been postponed in the hope that a satisfactory settlement can be effected by the Canadian Minister of Labour. [Since the above report was written cable messages have announced a stoppage.—EDITOR.] The Cobalt miners are in a better position than those engaged in the gold mines, as they receive in addition to their regular wages a bonus regulated according to the market price of silver. During June the bonus was increased by the amount of 25 cents per day, making the total $1·50 per day. It is hardly likely that the strike will take place so long as these favourable conditions continue. During May the Kerr Lake produced 105,582 oz., compared with 104,477 oz. in April. The production during the current year shows a decline of about 50% as compared with last year's output. For the five months ended with May 1918, the mine produced 1,085,793 oz. of silver, as compared with 528,358 for the first five months of 1919. Several new veins have been discovered on the old Foster property, one of which was found on the 40 ft. level, and is reported to be very high grade. Work has been started on the Mohawk property situated on the west side of Mud Lake. The Cobalt Provincial will increase the capacity of its mill from 40 to 100 tons. The McKinley-Darragh is exploring the undeveloped south-eastern part of its property adjacent to the Nipissing. The Peterson Lake has had a judgment in its favour by the Supreme Court in a protracted suit over the ownership of slimes deposited by the Dominion Reduction Company's mill in Peterson

Lake territory. The case was originally decided by the lower court in favour of the Peterson Lake and an appeal taken resulted in the judgment being confirmed. The silver content of the slimes is estimated as at least 500,000 oz.

MATACHEWAN.—This district is attracting a good deal of attention. The shaft on the Matachewan mine, formerly the Otisse, is down 140 ft., and is still in ore. The vein is about 30 ft. wide on the surface. Cross-cutting will be undertaken at the 200 ft. level. North-east of the Matachewan a group of claims known as the Matachewan Rand is being opened up.

WEST SHINING TREE.—Many properties in the northern portion of this area are under development, including the Wasapika, Miller-Adair, and Riel-Foisey, situated on the great Ribble vein, along which they extend continuously for nearly 10,000 ft. Other claims which are being actively worked are the West Tree, the Herrick, and the Atlas. On the latter property the andesite is cut by dykes of olivine diabase which is considered a highly favourable formation. The buildings on the Queen of Sheba were destroyed by a bush fire.

NORTH OF ENGLAND.

"THE TIMES" ARTICLE.—I hope that readers of the Magazine saw the valuable article in "The Times Trade Supplement," giving a short outline of what has happened in the lead and zinc mining industry since November last, and revealing the position as it stands to-day. The three concluding paragraphs are well worth quoting: "There has been no attempt to force the Government into a premature policy of protection, but the mines feel that they have a right to live until the position becomes a purely economic one. When the Government stocks are liquidated and the consumer is compelled to purchase in the world's market, the price of lead and zinc metal and the price of lead and zinc ores will find an economic level which would enable mining to be carried on in this country on a profitable basis. The Government has protected dyes, motor, paper-making, and other industries by means of restrictive licences and duties, but in this instance, the mine owners are actually expected to produce their ores at a price to compete with the reckless sale at a loss of Government purchases. An output bonus of £5 per ton should be given for a year or two at least, in any case, until abnormal conditions cease; but whatever is done should be done quickly and have sufficient permanence to give some security to the mine owners, who have for the last few years been the victims of an administration that it is difficult to describe in polite language."

ZINC.—There is little to say this month about markets. I hear that the smelters are being charged by the Government £11 per ton for zinc concentrates guaranteed to contain 45% of zinc. If that is so the smelters ought to be able to give mine owners certainly 30s. to 35s. per ton more for the material containing 50%. Smelters, however, are heavily stocked with concentrates, and are not in the market. I am told that the zinc smelters are getting considerable subsidies from the Government either in the form of direct subsidy or a guaranteed price which is considerably above the price of zinc in the open market. The Board of Trade has been asked for information on this point, but refuses to say anything. I am informed, by the way, that there are 2,000,000 tons of blende collected and stored at Broken Hill or lying at Port Pirie. I presume that this has already been paid for by the Government. A pretty fine penny there must be for the interest running.

LEAD.—As to lead the position is that large supplies are coming in and that they are being well absorbed. It is to be hoped that the Government stocks will not increase this month. The smelters decline to buy at other than ridiculously low prices. I believe in some cases they offer not more than £12. 10s. per ton. In only exceptional cases are odd lots being sold at a reasonable figure. I have heard of an isolated spot transaction or two in the neighbourhood of £17. 10s. per ton.

THORNTHWAITE MINE.—This mine has dismissed more than half of the men employed at it and is simply retaining a sufficient number to carry on what development work the the directors deem it advisable to have done. It is interesting to hear that when the management sent word to the Government department on the step that had been taken a reply was received that, as the matter was one which evidently applied to coal, it had been sent to the Coal Controller! Thereupon the management informed the Government department that as lead and zinc were not coal it would be advisable for the letter to go to the officials dealing with lead and zinc mines. No further communication, needless to say, has been received by the company from the department.

THRELKELD.—Developments at the Threlkeld mine up to date show a length of ore-bearing ground in the extension to the old mine of about 97 fathoms. The whole of this is payable ground, and the contents will average about one ton of lead to the fathom. Though this does not appear to be a very rich yield, it must be remembered that the mine is worked by an adit level and that consequently there is no pumping or winding. The stoping ground is very free, consisting of sandy quartz and narrow bands of fairly solid galena with a little blende. Above the adit level there is about 15,000 ft. of solid ground, and if this deposit goes up to the surface it must prove a very satisfactory venture to those who are interested in the property. The trial stope has been put up about 60 ft., and reveals a gradual improvement all the way as it rises.

BRANDLEHOW MINE.—This mine is now under the management of Mr. W. H. Borlase, who is engaged in sinking a new shaft which is about 35 fathoms deep. He hopes to carry it down about 55 fathoms, when lateral development will be undertaken.

WEARDALE.—At one of the mines at Stanhopeburn the men, who handed in their notices, have been definitely refused the Sankey award. The position does not allow of such a concession.

GOLDSCOPE.—Mr. Bennett Johns is vigorously opening out the Goldscope lodes in the Vale of Newlands, and is hoping to reach the intersection of the copper vein and Scalby's lode. This copper vein has only proved productive where intersected by other lodes. The total length of this adit level is 1,800 ft. Mr. Johns has gone past the old Goldscope bunch which was so rich, and is going on to the next intersection. The Goldscope mine has a romantic history. It was worked continuously for about 85 years, starting in Queen Elizabeth's day, and was closed by the civil wars in 1651, most of the miners being either killed or drafted into Cromwell's Army. The Dutch, who came with the Prince of Orange, re-opened the mine in 1690, and remained until 1715. For 130 years afterwards there was no record of what took place. It was re-opened by a private company in 1847, but it was offered for sale at the end of 18 months, after £5,000 had been spent, and Messrs. Clarke & Co. became the purchasers. Under the direction of Mr. Clarke fair success was secured. Mr. Clarke discovered a deposit of ore which far exceeded his expectations, the east lead vein being cut at a point where the adit level had been driven forward along the copper vein, about 60 fathoms from the old shaft. The deposit of ore measured 15 fathoms in length, and contained one vein of solid ore, 3 ft. in thickness, besides three or four smaller veins, varying from three to eight inches in thickness, and making a total of upwards of four feet of solid ore. The amount of profit realized in stoping out the ore below the adit level was about £25,000, and it is considered very probable that the ground above the level would return a profit, almost if not quite, equal to the amount forthcoming below. The mine continued to return large profits for many years, but ultimately the shaft became so deep that the waterwheel was no longer able to pump water, and the mine was abandoned in 1864.

SAN FRANCISCO.

[Owing to scarcity of news published in England relating to present conditions in Mexico, the following paragraphs from the pen of Mr. T. A. Rickard and appearing in the *Mining and Scientific Press* will be welcomed by readers.—EDITOR.]

MEXICAN CONDITIONS.—Signs are multiplying that even the long-suffering administration at Washington is becoming vexed with the Government of Carranza. The policy of watchful waiting was well-meant and might have succeeded if this leader of the so-called Constitutional party had made the most of the chance given to him, by the American Government, to establish law and order in Mexico. It is announced that "urgent representations" have been made to the Mexican Government for the punishment of those responsible for the murder of John W. Correll, an American citizen, the maltreatment of his wife, and the attempted murder of their son, at their ranch near Colonia, 27 miles north of Tampico. The mention of the locality is significant because a few days after Correll had been murdered the paymaster of the Gulf Refining Company, an American enterprise, was held up and robbed of $15,000 in gold which he was taking from Tampico to the oilfield ; and this was done after the local authorities had been notified of the route he would take and of the need for protection in going about his regular business. This was in so-called Carranza territory, that is, a region dominated by Federal troops, who, however, not only failed to give the proper protection to legitimate industry but, some of them, in uniform, actually raided a camp of the National Oil Company, at Panuco, and robbed the employees of their money and valuables. On top of these items of lawlessness, it is reported that the Mexican Government has prevented American oil-drillers from working on land that had been purchased from its Mexican owners in the ordinary way, that is, it was not a Government concession but private property. These incidents are in no way remarkable; more than 300 Americans have been killed in Mexico during the revolutionary period of the last eight years, and American properties innumerable have been looted or destroyed; the recent happenings have fresh significance only because they mark the near approach of a limit to the patience with which the American people have waited in the friendly hope that the Mexican would set his house in order and become a respectable neighbour. It is, of course, not a little absurd that a Government with a mission to assist in the establishment of civilized methods in Armenia and Dalmatia should shirk obligations at its back door. Apparently—and the wish may be father to the thought—the Administration at Washington is ready to turn from the consideration of mandatories far across the seas to the acceptance of a more logical and more pressing mandatory across the shallow waters of the Rio Grande. It is about time. Every intelligent citizen in this country must be tired of the *opéra bouffe* varied by blackmail, rapine, and massacre that has flourished for nine years in Mexico, into which American men and American capital were cordially invited to come by Porfirio Diaz during the more than thirty years of his presidency. These alarums and excursions at Columbus, Cananea, and Juarez are ceasing to be even picturesque. We understand why a brigand like Villa and a desperado like Zapata are enabled to continue their depredations year after year in mockery alike of the *de facto* and *de jure* government of Carranza who is ready to ally himself with any enemy of the United States that makes him an offer of money.

The fact is that our southern neighbours are Indians with a slight admixture of alien, chiefly Spanish, stock; and even that small infusion of European blood has become less influential during the disorderly period since Diaz resigned, because the larger part of the Spanish population has emigrated to a safer domicile, shirking their responsibilities and leaving their hapless country to the more ignorant *mestizos* and the full-blooded *indios*. Mexico to-day is only 10% white, and, what is even more significant, it is 85% illiterate, in this respect being comparable with Russia, which, like Mexico, is for that reason entirely unprepared for any form of representative government. Since Humboldt's visit, in 1810, the mixed population of Mexico has more than doubled. Both Diaz and Huerta belonged to this group. Even the undiluted Indian has risen to positions of power. We are not dealing with a Spanish colony, but with a people among whom liberalism works as an explosive and to whom the contact with our material civilization has been the cause of persistent political ferment and systematic corruption. Mexico is in the kindergarten of social evolution. Consider Carranza's attempts to administer the country with a combination of crazy idealism and sordid craftiness. He is not a soldier, he rose to power by means of the military ability—at least for the sort of fighting that obtains in Mexico—of Villa, Obregon, and Angeles, all of whom are now opposing him. He holds his remaining generals only by permitting them to graft at their pleasure. The Federal appropriations passed by the Mexican Congress for 1918 included 120,755,631 pesos for the Department of War and Marine; this was two-thirds of the entire budget and nearly all of it went to the army, which nevertheless is unable either to drive Villa's band of outlaws into the mountains or to make a decent showing when he puts up a fight periodically. The reason why the Federal troops are so ineffective is because the money voted for their maintenance is squandered by the generals in riotous living in the City of Mexico and because the officers in the field actually sell arms and ammunition to such bandits as Villa and Zapata. Although the latter is dead, others of his kind are numerous. The military authorities have to be bribed in order to get anything, from the use of a railroad car to the permission to employ labour. The names of 37 defaulting army paymasters have been published in the newspapers of Mexico City. Carranza's revenue largely exceeds that collected by Diaz, and he gets it not by just taxation but by confiscation, which has paralysed industry. Much of the rolling stock of the railways has been destroyed during the guerilla warfare, and what has survived is so out of repair that only two lines, those from Laredo and from Vera Cruz to the capital, are able to maintain a regular service. The population in the bigger cities, such as the capital, Vera Cruz, Guadalajara, and San Luis Potosi, has been increased abnormally by thousands of utterly destitute people, brought thither largely by the fear of living in the country, where they are the victims of recurrent brigandage. Agriculture is neglected because it is unsafe to remain on the farm, the produce of which likewise is at the mercy of bands of marauders. Mexico may have a government *de facto*, it has none *de jure*. It neither possesses the power nor shows the inclination to discharge its obligations either to its own people or to those of a neighbouring country.

PERSONAL

HERBERT AINSWORTH is here from Johannesburg.

R. F. ALLEN is home from Nigeria.

H. STANDISH BALL, late Assistant Inspector of Mines, G.H.Q., France, has joined the firm of Albert François, cementation engineers.

M. W. VON BERNEWITZ is now associated with WALTER HARVEY WEED in the production of "The Mines Handbook."

FRANCIS L. BOSQUI has opened an office at 90, West Street, New York.

F. O'D. BOURKE is here from Naraguta, Nigeria.

VICARS W. BOYLE, manager of the Bongwelli mine, is home from Nigeria, after an absence of four years.

ARTHUR J. CADDICK, consulting metallurgical engineer to the Rio Tinto Co., is here from Spain.

J. MORROW CAMPBELL has received the degree of D.Sc. from Glasgow University for his thesis on "Laterite" which was published in this Magazine.

J. E. CLENNELL is here from the United States.

SIR HUGH C. CLIFFORD has succeeded SIR F. D. LUGARD as Governor of Nigeria.

HENRY F. COLLINS is visiting Spain.

D. L. GODDARD has been appointed manager of the Chillagoe smelter, Queensland.

BRIGADIER-GENERAL F. G. GUGGISBERG, R.E., has been appointed Governor of the Gold Coast.

ELLWOOD HENDRICK, consulting editor of *Chemical and Metallurgical Engineering*, has gone to Venezuela.

J. A. HULME, manager of the Mount Morgan concentration plant, has been appointed manager for the Kingsgate Molybdenite Co., Glen Innes, New South Wales.

BERTRAM HUNT is back from Panama.

JAMES M. HYDE has been appointed professor of metallurgy in the Stanford University, San Francisco.

R. UNDERWOOD JARVIS is home from Naraguta, Nigeria.

DR. W. R. JONES is coming to England from Burma by way of China and the United States.

F. R. LYNCH is here from Johannesburg.

R. L. NAISH, manager for the Kamunting Tin Dredging Co., is here from the Federated Malay States.

LEWIS A. PARSONS, lately with the International Nickel Company, has been appointed associate editor of the *Mining and Scientific Press*.

A. G. PLEWS has returned from Burma.

PROFESSOR J. W. RICHARDS, of Lehigh University, is visiting electro-chemical plants in Norway.

WILLIAM ROBERTSON, smelter manager for the Broken Hill Associated Smelters, is visiting metallurgical plants in the United States.

WILLIAM RUSSELL has gone to Norway.

JAMES SCOTT has gone to Spitsbergen as mining geologist to the Scottish Spitsbergen Syndicate, Ltd.

LT. R. O. SIMON, R.N.V.R., has returned from the Archangel front.

SYDNEY A. R. SKERTCHLY is expected from Peru.

C. LONSDALE SMITH has been appointed manager for the Tungsten Mines Co., Frogmore, New South Wales.

SIR ARTHUR STEEL-MAITLAND has joined the board of the Rio Tinto Company.

W. H. STRONGE is leaving for Nigeria.

H. LESLIE SWIFT has left for Nigeria to take up an appointment with the Jantar Company.

HARRY J. WOLF has resigned the position of professor of mining in the Colorado School of Mines and has joined the editorial staff of the *Engineering and Mining Journal*.

EDWARD HALL WATSON was elected president of the North-East Siberian Miners' Federation in December last, at a mass meeting of the mining fraternity held at Bodaibo. This is the first time that a foreigner has filled such a position in Siberia.

MAJOR GERARD W. WILLIAMS, R.E., D.S.O., M.C., has been demobilized and is leaving for Nigeria.

TRADE PARAGRAPHS

JAMES W. CARR & CO., LTD., of 35, Queen Victoria Street, London, E.C.4., announce that they have been appointed sole agents for London and the southern and eastern counties for "Velos Vanadium" high-speed steel tools made by Walter Spencer & Co., Ltd., Crescent Steel Works, Sheffield.

THE BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO., LTD., of Manchester, send us a number of leaflets relating to various accessories for electric power plant. These deal with direct-current ammeters and voltmeters, oil-immersed motor-control units for slip-ring type motors, and consumer's oil-switch cubicles.

JNO. HY. ANDREW & CO., LTD., of the Toledo Steel Works, Sheffield, send us their catalogue of special steels and steel manufactures. Their Toledo mining drills are known throughout the world, and they produce large amounts of steel used in the manufacture of mining ropes. Since the firm was made into a private limited liability company in 1898, Lord Beresford has been chairman continuously.

THE MINERALS CONCENTRATION CO., of 4, London Wall Buildings, London, E.C.2., have issued a pamphlet describing the rotary concentrator invented by W. W. Richardson. We described the system in our issue of October, 1917. It is intended particularly for the recovery of tin, and can be applied to the concentration of ore, slime, or gravel. A demonstration plant is at work in London.

THE JOHNSON ENGINEERING WORKS, with offices at First National Bank Building, Chicago, are the makers of the MARATHON mill. As readers are aware this is a tube-mill in which a series of parallel steel rods are used instead of pebbles or balls. The length of the mills depend on the duty required, whether they are to be used for coarse or fine grinding, or sliming. The company issue a number of pamphlets giving the results of tests at copper, lead, and other mines.

RUSTON & HORNSBY, LTD., of Lincoln, Grantham, and Stockport, have issued an elaborate and handsome album describing and illustrating the wide range of war manufactures. As regards peace manufactures, among their specialties of use to mining men are steam shovels and similar excavators, gas and oil engines, suction gas plant, and traction engines. Their suction producers are adapted for the combustion of all kinds of vegetable refuse and low-grade coal and charcoal.

EDGAR ALLEN & CO., LTD., of the Imperial Steel Works, Sheffield, have issued a new catalogue dealing with plant and machines of interest to mining engineers. Their specialities are the "Stag" jaw-crusher, the "Stag" granulator or fine jaw-crusher, high-speed rolls, cubing rolls for producing lumps 4 in. cube, coal-breaking rolls, coke-breaking rolls, the "Stag" ball-mills, the "Stag" tube-mills, the "Stag" pulverizing cylinders, air separators used for classifying ground material in an upward current of air, trommels or revolving screens, spiral conveyors, belt-conveyors, shaking conveyors, revolving driers, etc. The catalogue contains full details of dimensions, power required, and materials of construction, and notes of the applications of the various machines.

DAILY LONDON METAL PRICES: OFFICIAL CLOSING PRICES ON
Copper, Lead, Zinc, and Tin per Long Tons; Silver

	SILVER	COPPER			LEAD	
		Standard Cash	Standard (3 mos.)	Electrolytic	Best Selected	Soft Foreign
July	d.	£ s. d. £ s. d	£ s d. £ s. d	£ s. d. £ s. d	£ s. d. £ s. d.	£ s. d. £ s. d
11	$53\frac{1}{4}$	94 15 0 to 95 10 0	95 15 0 to 96 0 0	99 0 0 to 104 0 0	99 0 0 to 100 0 0	23 15 0 to 24 7 6
14	$53\frac{5}{8}$	97 10 0 to 97 15 0	98 7 6 to 98 10 0	100 0 0 to 107 0 0	99 0 0 to 100 0 0	23 15 0 to 24 7 6
15	$53\frac{7}{8}$	100 15 0 to 101 0 0	101 10 0 to 101 15 0	103 0 0 to 111 0 0	103 0 0 to 104 0 0	23 12 6 to 24 7 6
16	$54\frac{1}{8}$	105 0 0 to 105 10 0	105 10 0 to 106 0 0	106 0 0 to 115 0 0	103 0 0 to 104 0 0	23 17 6 to 24 10 0
17	$54\frac{1}{4}$	102 10 0 to 103 0 0	103 10 0 to 104 0 0	109 0 0 to 117 0 0	103 0 0 to 104 0 0	23 17 6 to 24 10 0
18	$54\frac{1}{4}$	102 15 0 to 103 0 0	103 10 0 to 103 15 0	109 0 0 to 118 0 0	109 0 0 to 110 0 0	23 15 0 to 24 10 0
21	$54\frac{1}{4}$	104 15 0 to 105 0 0	105 10 0 to 105 15 0	109 0 0 to 118 0 0	109 0 0 to 110 0 0	23 15 0 to 24 10 0
22	$54\frac{3}{8}$	104 15 0 to 105 0 0	105 10 0 to 105 15 0	109 0 0 to 118 0 0	109 0 0 to 110 0 0	23 10 0 to 24 0 0
23	$54\frac{9}{16}$	103 15 0 to 104 0 0	104 0 0 to 104 10 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	23 10 0 to 24 5 0
24	$54\frac{7}{8}$	106 0 0 to 106 10 0	106 10 0 to 107 0 0	110 0 0 to 123 0 0	109 0 0 to 110 0 0	23 12 6 to 24 5 0
25	$55\frac{1}{16}$	106 0 0 to 106 5 0	106 5 0 to 106 10 0	110 0 0 to 123 0 0	110 0 0 to 111 0 0	23 15 0 to 24 7 6
28	$55\frac{3}{16}$	107 5 0 to 107 10 0	107 10 0 to 107 15 0	110 0 0 to 125 0 0	110 0 0 to 111 0 0	24 0 0 to 24 12 6
29	$55\frac{1}{4}$	107 0 0 to 107 5 0	107 5 0 to 107 10 0	110 0 0 to 125 0 0	110 0 0 to 111 0 0	24 0 0 to 24 12 6
30	$56\frac{5}{16}$	104 10 0 to 104 15 0	105 0 0 to 105 5 0	110 0 0 to 125 0 0	110 0 0 to 111 0 0	24 0 0 to 24 12 6
31	$55\frac{9}{16}$	102 0 0 to 102 5 0	102 10 0 to 102 15 0	110 0 0 to 125 0 0	110 0 0 to 111 0 0	24 0 0 to 24 15 0
Aug.						
1	$55\frac{3}{4}$	100 15 0 to 101 0 0	101 10 0 to 101 15 0	110 0 0 to 125 0 0	110 0 0 to 111 0 0	24 5 0 to 25 0 0
5	$56\frac{1}{8}$	99 5 0 to 100 10 0	100 5 0 to 100 10 0	110 0 0 to 125 0 0	110 0 0 to 111 0 0	25 5 0 to 25 15 0
6	57	96 0 0 to 96 5 0	97 0 0 to 97 5 0	108 0 0 to 123 0 0	110 0 0 to 111 0 0	24 15 0 to 25 10 0
7	$57\frac{3}{8}$	95 0 0 to 95 5 0	96 0 0 to 96 5 0	106 0 0 to 121 0 0	110 0 0 to 111 0 0	24 2 6 to 24 17 6
8	58	90 10 0 to 90 15 0	91 10 0 to 91 15 0	105 0 0 to 118 0 0	106 0 0 to 107 0 0	24 2 6 to 24 17 6

METAL MARKETS

COPPER.—During the month of July the market witnessed a further sensational advance in values of this metal. The source of the strength is, as before, the United States, where the large producers have consistently advanced their prices, and as they are working in harmony, at least so far as their shipping business is concerned, through the Copper Export Association, they can pretty well ask any price they like, and buyers must either pay up or go without. Of course, there are still large stocks of copper in this country, and it might be supposed that these would enable buyers on this side to be more or less independent of America. Unfortunately the stock of wire-bars here appears to be negligible, if indeed there is any at all, and as this is the particular shape most in demand, American sellers have reaped the benefit. For some little time competition was seen in this market from Australian metal, which sold at rather less than American prices, and no doubt sellers of this took all the business that was going at the time. This selling, however, appears to have ceased for the present, no doubt owing to difficulties concerning shipment from Australia. The strong tone of copper in America, coupled with the low rates of exchange ruling between the two countries, considerably enhanced the value of refined metal on this side, and large buying of standard copper has been seen on the Metal Exchange, where a considerable amount of speculation appears to have been indulged in. This has made the position somewhat dangerous, and if anything untoward happened to the market in America, prices here of standard copper might react very sharply. Since the beginning of August weakness has set in in America and the quotations have receded again. Generally speaking the position is not regarded any too favourably on this side, as the high prices of the metal have retarded legitimate demand, and the level to which prices have been put are hardly considered justified in the circumstances. The Government stock on July 1 in this country was 44,298 tons, or 3,694 tons less than a month earlier.

The average price of cash standard copper in July, 1919, was £99. 14s. 5d.; June, 1919, £83. 0s. 6d.; July, 1918, £120. 3s. 3d.; June, 1918, £110. 5s.

TIN.—Business in this article with home consumers has not been any too good during the past month, first of all owing to the general quiet condition which was prevailing in the tinplate trade in South Wales, and secondly owing to the industrial crisis precipitated by the rise in coal costs, which has left users in some doubt as to the future, and created an atmosphere of caution. The outlook in regard to tinplates seems now more favourable, and therefore it is to be expected that an improvement will result in business in the raw material. In spite of these factors, trading in the standard tin market has been very active, the re-opening of business in the metal with the United States owing to the raising of the import embargo having stimulated considerable interest in the article, and at the same time given rise to a certain amount of speculative buying in anticipation of the better times coming. Quite a large business has already been done on this side for shipment to America, and only recently about 800 tons of tin are reported to have been shipped from here for that destination. The United States is also believed to have bought considerably in the East for direct shipment. At all events, a large business has been moving in the Straits Settlements, and it is believed that the stocks there must have been very considerably reduced. It is also suggested that some of the selling which has taken place in the standard market in London has been for account of the Federated Malay States Government. Another factor which may influence the future of the market is the re-opening of trading relations with Germany, but the extent of this business in view of financial considerations is difficult to forecast. There are as yet no signs of the holders of tin in China liquidating their stocks, and at present definite figures as to the extent of these are not available.

The average price of cash standard tin in July, 1919, was £253. 5s. 1d.; June, 1919, £238. 8s. 2d.; July, 1918, £359. 17s. 9d.; and June, 1918, £331. 10s.

LEAD.—The general sentiment in regard to this metal has rather improved during the past month, and values have advanced to about the extent of 30s. per ton, in spite of the fact that the stocks in this country still continue enormous, and that consumption of the metal is not on a particularly large scale. The stocks here, however, being in the hands of the Government, are not by any means pressed for sale, and American

THE LONDON METAL EXCHANGE.
per Standard Ounce.

Zinc (Spelter)	Standard Tin — Cash	Standard Tin — 3 mos.
£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
41 10 0 to 42 5 0	246 0 0 to 246 10 0	245 10 0 to 246 0 0
41 15 0 to 42 15 0	245 10 0 to 246 0 0	245 10 0 to 245 15 0
42 10 0 to 43 15 0	250 0 0 to 250 5 0	249 10 0 to 249 15 0
43 15 0 to 44 15 0	254 10 0 to 254 15 0	254 5 0 to 254 10 0
43 10 0 to 44 10 0	251 0 0 to 251 10 0	250 10 0 to 251 0 0
43 10 0 to 44 5 0	254 5 0 to 254 10 0	253 15 0 to 254 0 0
43 15 0 to 44 15 0	256 0 0 to 256 5 0	255 15 0 to 256 0 0
43 10 0 to 44 0 0	256 0 0 to 256 5 0	255 10 0 to 255 15 0
43 5 0 to 43 15 0	255 10 0 to 255 15 0	254 5 0 to 254 15 0
43 5 0 to 43 15 0	256 5 0 to 256 15 0	255 10 0 to 255 15 0
43 5 0 to 43 15 0	259 15 0 to 260 5 0	258 10 0 to 258 15 0
42 15 0 to 43 15 0	268 0 0 to 268 10 0	266 0 0 to 266 10 0
42 10 0 to 43 10 0	269 15 0 to 270 5 0	267 5 0 to 267 15 0
41 10 0 to 42 10 0	268 0 0 to 268 5 0	266 0 0 to 266 5 0
41 0 0 to 41 5 0	271 0 0 to 271 10 0	267 0 0 to 267 10 0
41 5 0 to 41 15 0	275 0 0 to 275 10 0	269 0 0 to 269 10 0
40 10 0 to 41 10 0	276 0 0 to 277 0 0	268 0 0 to 268 10 0
39 15 0 to 40 15 0	276 0 0 to 276 10 0	263 0 0 to 263 10 0
38 10 0 to 39 0 0	275 0 0 to 276 0 0	259 15 0 to 260 0 0
38 10 0 to 39 0 0	260 0 0 to 260 10 0	256 0 0 to 256 10 0

competition has been absent, there being apparently a sufficiency of demand in the United States to take care of the production there. In addition, exchange rates militate against competitive offers from that country to this side. As regards Australian metal, it is understood that the production there ceases for the present at the end of July. In addition to these factors, it is reported that some selling arrangement has been, or is about to be entered into, for the purpose of eliminating competition, this resulting in Spanish lead being only offered to the Continent, and Australian lead to this country. Besides this, the market level seemed to have got down to below cost of production. The general result has been that a more confident feeling has been exhibited as to the future, and a considerable business has been done on the Metal Exchange, where all metal coming on offer was easily absorbed, and values gradually improved. The Government stocks of soft pig lead in this country on July 1 were 121,135 tons, or an increase of 1,228 tons since June 1.

The average prices of soft pig lead: July, 1919, £23. 14s 2d.; June, 1919, £22. 12s. 2d.; July, 1918, £29; June, 1918, £29.

SPELTER.—This metal has also seen fair markets during the past month, the strength of the position having its source, like that of copper, in America, where values have fairly steadily improved. The general conditions which have caused the advance in America have been the reluctance of producers to offer freely, being for the most part fairly well booked up, a good export and improving domestic demand there, the strong position of the ore market, and lastly the optimistic sentiment in regard to metal business in general and particularly as regards copper. Added to the rising prices in America a declining rate of exchange had to be considered, and prices here responded. A very considerable interest has been taken in the metal in the market on 'Change, and quite large quantities have changed hands. To a certain extent the business was speculative, but, apart from that, consumers bought fairly freely, and it is believed that the Government have been able to sell not unimportant quantities. Latterly the rising prices, coupled with the unsatisfactory industrial situation, have caused the demand from users to ease off, and prices reacted downward to a small extent, being assisted in this by the rather easier tone in the American market. Taking a longer view, however, of the situation, it is generally regarded as favourable. The Government stocks of G.O.B. spelter on July 1 were 26,059 tons, or 632 tons less than a month earlier. The stocks of refined spelter were 13,356 tons or 1,619 tons more than on June 1.

Average prices of spelter: July, 1919, £42. 3s. 10d.; June, 1919, £36. 19s. 6d.; July, 1918, £52.

ZINC DUST.—Australian high-grade 88–92% purity is quoted at £70 per ton f.o.r.

ANTIMONY.—The price of English regulus has now been reduced by £5 to £40 per ton. Two prominent firms in this trade have been appointed agents for the sale of the unsold Government stocks. These stocks on July 1 amounted to 4,368 tons, or 132 tons less than a month previously. Foreign regulus on spot seems to have been fairly scarce, and is held for about the same price as English. Owing to an improvement in the market in France, there seems little prospect of further imports from there in the meantime.

ARSENIC.—The market has been very firm and the price of white stands at about £50 to £54 per ton.

BISMUTH.—12s. 6d. nominal per lb.

CADMIUM.—6s. 6d. to 6s. 9d. per lb.

ALUMINIUM.—£150 per ton for the home trade.

NICKEL has been advanced for the home trade, to £205 per ton, while for export the price is unchanged at £210.

COBALT METAL.—12s. 6d. to 13s. per lb.

COBALT OXIDE.—7s. 9d. per lb.

PLATINUM.—450s. nominal per oz.

PALLADIUM.—500s. nominal per oz.

QUICKSILVER.—The market has been firm, and prices have advanced to £23 to £24.

SELENIUM.—12s. to 15s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER is quiet and stands at about £43 to £45 per ton.

MANGANESE ORE.—The market is quiet, without much change in quotations, which are about 2s. 2d. to 2s. 3d. c.i.f. per unit.

TUNGSTEN ORES.—Wolframite 65% 30s. per unit, scheelite 65% 30s. per unit.

MOLYBDENITE.—85% 75s. per unit.

SILVER.—The market has fluctuated in an upward direction in this country, and at the end of July the price of spot standard bars was $55\frac{9}{16}$d. Prices have continued to advance.

CORUNDUM.—90% remains nominal.

GRAPHITE.—80% about £40 to £45 per ton nominal c.i.f. U.K.

IRON AND STEEL.—These markets have latterly been in a state of suspended animation owing to the rise of 6s. in the price of coal which has necessitated a reconsideration of costs, and at the time of writing future prices of steel are rather uncertain, although in the case of sheets, 30s. is hinted at as a possible advance. The feature has been the very large demand for steel plates, which appear to be now exceedingly difficult to procure. In other lines, however, the stringency is not quite so great. A good deal has been heard of American competition, and there is no doubt that this is a very serious factor, especially in view of the generally rising prices here. Of course, deliveries from America are not too quick, owing to the freight situation, so that purchases from that country are not quite so attractive as the prices quoted might suggest. In regard to pig iron, it appears that prices are not likely to be advanced further, even in face of the rise in coal, in view of the fact that during the period of great demand recently prices steadily went up, so that this rise in costs was virtually discounted beforehand.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
January, 1918	694,121	19,991	714,182	3,033,653
February	637,571	22,188	659,759	2,802,477
March	677,008	19,273	696,281	2,957,614
April	697,733	19,366	717,099	3,046,045
May	720,539	20,778	741,317	3,148,915
June	708,908	18,788	727,696	3,091,058
July	716,010	20,189	736,199	3,127,174
August	719,849	20,361	740,210	3,144,211
September	686,963	21,243	708,206	3,008,267
October	667,955	11,809	679,764	2,887,455
November	640,797	17,904	658,701	2,797,983
December	630,505	10,740	641,245	2,723,836
Year 1918	8,197,959	221,734	8,419,693	35,768,688
January, 1919	662,205	13,854	676,059	2,871,718
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
April 30, 1918	182,492	11,322	4,753	198,567
May 31	179,879	11,211	4,773	195,863
June 30	179,028	11,473	4,747	195,248
July 31	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	196,294
September 30	179,399	12,108	4,889	196,395
October 31	173,153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637
January 31, 1919	160,599	11,848	3,539	175,986
February 28	172,359	11,868	4,264	188,491
March 31	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d	s. d.	s. d.	£
July, 1918	2,167,869	27 10	21 2	6 6	702,360
August	2,158,431	28 1	21 7	6 3	676,146
September	2,060,635	28 2	22 0	5 10	600,330
October	2,015,144	28 0	22 5	5 3	531,774
November	1,899,925	28 5	23 1	5 1	480,102
December	1,855,991	28 7	23 0	5 6	507,860
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129
January, 1919	1,942,329	28 9	23 0	5 8	547,793
February	1,816,352	28 9	23 2	5 6	498,204
March	2,082,469	28 2	22 6	5 6	573,582
April	1,993,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715

Production of Gold in Rhodesia and West Africa

	Rhodesia.		West Africa.	
	1918	1919	1918	1919
	£	£	£	£
January	253,807	211,917	107,863	104,063
February	232,023	220,885	112,865	112,616
March	230,023	225,808	112,605	112,543
April	239,916	213,160	117,520	109,570
May	239,205	218,057	126,290	100,827
June	225,447	214,215	120,273	106,612
July	251,740	—	117,581	—
August	257,096	—	120,526	—
September	247,885	—	115,152	
October	136,780	—	61,461	
November	145,460		108,796	
December	192,870		112,621	
Total	2,652,250	1,304,042	1,333,553	646,231

Transvaal Gold Outputs.

	June, 1919	
	Treated	Value
	Tons	£
Aurora West	12,500	12,933
Bantjes	—	—
Barrett	—	745
Brakpan	45,500	88,210
City & Suburban	18,226	27,626
City Deep	48,000	94,347
Cons. Langlaagte	43,200	54,282
Cons. Main Reef	47,000	72,050
Crown Mines	168,000	231,821
Durban Roodepoort Deep	18,400	28,669
East Rand P.M.	111,000	145,323
Ferreira Deep	33,000	50,629
Geduld	43,800	64,979
Geldenhuis Deep	47,200	57,228
Ginsberg	7,900	9,267
Glynn's Lydenburg	3,830	6,348
Goch	14,740	13,300
Government G.M. Areas	118,500	204,595
Heriot	11,380	15,868
Jupiter	22,300	23,873
Kleinfontein	53,860	65,889
Knights Central	21,700	26,382
Knights Deep	95,000	74,471
Langlaagte Estate	40,900	49,296
Luipaard's Vlei	21,740	—
Meyer & Charlton	14,030	40,103
Modderfontein	79,000	172,398
Modderfontein B	54,500	120,071
Modderfontein Deep	41,500	93,475
New Unified	11,600	11,618
Nourse	40,600	53,048
Primrose	19,500	18,066
Princess Estate	19,600	25,604
Randfontein Central	150,000	171,119
Robinson	35,400	35,687
Robinson Deep	50,000	66,786
Roodepoort United	23,100	21,884
Rose Deep	50,600	59,357
Simmer & Jack	57,400	58,899
Simmer Deep	43,600	45,214
Springs	33,500	62,812
Sub Nigel	10,400	25,797
Transvaal G.M. Estates	15,590	25,800
Van Ryn	35,250	34,336
Van Ryn Deep	46,700	99,968
Village Deep	39,900	61,193
Village Main Reef	17,400	22,162
West Rand Consolidated	31,620	36,933
Witwatersrand (Knights)	33,900	40,842
Witwatersrand Deep	29,900	35,916
Wolhuter	30,700	38,886

West African Gold Outputs.

	June, 1919	
	Treated	Value
	Tons	£
Abbontiakoon	7,267	16,203
Abosso	6,980	12,290
Ashanti Goldfields	7,752	36,525
Prestea Block A	14,726	24,930
Taquah	4,980	13,796
Wassau	2,490	2,496

Rhodesian Gold Outputs.

	June, 1919	
	Treated	Value
	Tons	£
Antelope	3,225	4,335
Cam & Motor	—	—
Eldorado Banket	2,009	4,233
Falcon	15,203	27,539*
Gaika	3,052	5,294
Globe & Phœnix	6,040	8,311†
Lonely Reef	4,520	23,992
Rezende	5,500	12,644‡
Rhodesia, Ltd.	350	1,028
Shamva	53,013	36,174
Transvaal & Rhodesian	1,750	5,000
Wanderer	—	—

* Gold, Silver and, Copper; † Ounces Gold; ‡ Gold & Silver.

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January, 1918	*	73,703	*	*
February	*	76,987	*	*
March	*	69,730	*	*
April	*	66,079	*	*
May	*	73,701	*	*
June	*	74,904	*	*
July	*	72,081	*	*
August	*	76,156	*	*
September	*	74,057	*	*
October	*	71,439	*	*
November	1,444	70,711	72,155	306,494
December	2,739	61,314	64,053	272,208
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	*nil*	66,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316,862
July	680	68,028	68,708	292,852

* By direction of the Federal Government the export figures from July, 1916, to November, 1918, were not published.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1918	1919	1918	1919	1918	1919
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	25,000	18,000
February	58,113	46,955	45,470	43,330	28,000	24,000
March	65,412	40,267	48,020	48,000	30,000	16,000
April	29,620	23,818	47,600	61,200	30,000	24,000
May	87,885	—	46,740	38,200	45,000	16,000
June	45,765	—	51,420	44,600	32,000	17,000
July	64,347	—	51,000	—	25,000	—
August	61,163	—	44,600	—	21,000	—
September	65,751	—	45,900	—	32,000	—
October	*	—	54,400	—	40,000	—
November	*	—	38,200	—	25,000	—
December	70,674	—	56,281	—	38,000	—
Total	674,655	147,279	578,213	272,430	370,000	115,000

* Figures not received.

Australasian Gold Outputs.

	June, 1919	
	Treated	Value
	Tons	£
Associated	5,768	8,191
Associated Northern Blocks — Iron Duke	—	1,866*
Associated Northern Blocks — Victorious	2,138	3,040
Blackwater	1,901	3,903
Bullfinch	5,400	4,826
Golden Horseshoe	12,012	22,401
Great Boulder Prop.	12,854	37,291
Ivanhoe	17,636	30,210
Kalgurli	2,976	5,706
Lake View & Star	10,231	12,223
Mount Boppy	—	—
Oroya Links	1,524	10,388†
Progress	1,460	1,681
Sons of Gwalia	9,629	13,873
South Kalgurli	7,274	11,372
Talisman	—	—
Waihi	16,037	26,259‡
Waihi Grand Junction	11,910	17,620§

* Surplus; † Total receipts; ‡ Gold and Silver to July 12.
§ 48 days to July 12.

Miscellaneous Gold Output.

	June, 1919	
	Treated	Value
	Tons	£
Barramia (Sudan)	—	—
Esperanza (Mexico)	—	—
Frontino & Bolivia (Colombia)	2,807	10,162
Nechi (Colombia)	—	—
Ouro Preto (Brazil)	7,000	10,009
Pato (Colombia)	—	—
Philippine Dredges (Philippine Islands)	—	328§
Plymouth Cons. (California)	10,300	13,114
St. John del Rey (Brazil)	—	36,000
Santa Gertrudis (Mexico)	30,990	25,520††
Sudan Gold Field (Sudan)	1,620	1,840

§ Ounces, fineness not stated. †† Profit, gold and silver.

Production of Gold in India.

	1916	1917	1918	1919
	£	£	£	£
January	192,150	190,047	176,030	162,270
February	183,264	180,904	173,343	153,775
March	186,475	189,618	177,950	162,790
April	192,208	185,835	176,486	162,550
May	193,604	184,874	173,775	164,080
June	192,469	182,426	174,375	162,996
July	191,404	179,660	171,950	163,795
August	192,784	181,005	172,105	—
September	192,330	183,630	170,360	—
October	191,502	182,924	167,740	—
November	192,298	182,388	157,176	—
December	205,164	190,852	170,630	—
Total	2,305,652	2,214,163	2,061,920	1,034,256

Indian Gold Outputs.

	June, 1919	
	Tons Treated	Fine Ounces
Balaghat	2,550	2,151
Champion Reef	11,430	6,974
Hutti (Nizam's)	—	900
Jibutil	—	—
Mysore	24,330	13,625
North Anantapur	900	918
Nundydroog	8,750	6,463
Ooregum	12,800	7,328

Base Metal Outputs

		June, 1919
Arizona Copper	Short tons copper	1,200
British Broken Hill	Tons lead concentrate	—
	Tons zinc concentrate	—
	Tons carbonate ore	—
Broken Hill Block 10	Tons lead concentrate	—
	Tons zinc concentrate	—
Burma Corp.	Tons refined lead	1,531
	Oz. refined silver	178,647
Cordoba Copper		—
Freemantle Trading	Long tons lead	—
North Broken Hill	Tons lead	—
	Oz. silver	—
Poderosa	Tons copper ore	153
Rhodesian Broken Hill	Tons lead and zinc	1,346
Tanganyika	Long tons copper	2,035
Tolima	Tons silver-lead concentrate	45
Zinc Corp.	Tons zinc concentrate	—
	Tons lead concentrate	—

Imports of Ores and Metals into United Kingdom.
Long tons.

	July	Year 1919
	Tons	Tons
Iron Ore	632,618	3,188,502
Copper Ore	1,108	9,865
,, Precipitate	1,062	6,957
,, Metal	5,571	74,432
Copper and Iron Pyrite	41,966	177,971
Tin Concentrate	1,741	22,515
,, Metal	2,129	10,714
Manganese Ore	12,679	207,280
Lead, Pig and Sheet	13,480	165,738
Zinc (spelter)	6,831	61,736
Zinc Oxide	1,737	2,968
Barytes	2,757	12,828
Rock Phosphate	13,100	218,241
Brimstone	50	5,211
Boracic Compounds	1,515	7,297
Nitrate of Potash	743	6,090
	lb.	lb.
Quicksilver	381,987	1,695,087

United States Metal Exports and Imports.

Exports.	April Tons.	May Tons.	Imports.	April Tons.	May Tons.
Copper Ingots	7,965	8,342	Antimony	433	261
Copper Sheets	580	382	Tin Ore	534	2
Copper Wire	1,478	1,768	Tin	225	200
Lead, Pig	2,375	1,017	Manganese Ore	59,470	19,644
Zinc	16,075	5,023	Tungsten Concentrate	314	285
Zinc Sheets	962	596	Pyrites	25,294	33,262

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Year 1918 Tons	June 1919 Tons	Year 1919 Tons
Nigeria:			
Abu	33	1½	12
Anglo-Continental	207	–	79
Benue	146	7	49
Berrida	—	–	1
Bisichi	275	13	70
Bongwelli	17	3	23
Dua	60	2	37
Ex-Lands	342	–	118
Filani	37	2	10
Forum River	274	10	82
Gold Coast Consolidated	30	3	17
Gurum River	99	6	57
Jantar	141	8	57
Jos	228	11¼	123
Kaduna	178	9	112
Kano	60	13	82
Kassa-Ropp	133	12	72
Keffi	118	–	30
Kuru	12	30	149
Kuskie	21	–	3
Kwall	108	–	7
Lower Bisichi	99	4	48
Lucky Chance	27	2	16
Minna	40	3	17
Mongu	476	35	280
Naraguta	478	–	161
Naraguta Extended	280	22	105
New Lafon	198	21	125
Nigerian Tin	87		25
Ninghi	—	4	20
N.N. Bauchi	435	32	175
Offin River	120	4	32
Rayfield	689	50	357
Ropp	836	90	509
Rukuba	132	2	19
South Bukeru	94	5	28
Sybu	40	3	17
Tin Areas	96	4	38
Tin Fields	108	10	88
Toro	17	·	3
Federated Malay States:			
Chenderiang	179	–	52
Gopeng	979	65	441
Idris Hydraulic	136	18	111
Ipoh	245	16	77
Kamunting	236		96
Kinta	478	34	213
Kledang	28	5	10
Lahat	399	44	198
Malayan Tin	730	59	352
Pahang	1,877	196	1,071
Rambutan	207	–	75
Sungei Besi	408	36	150
Tekka	508	36	233
Tekka-Taiping	400	26	156
Tronoh	1,364	117	721
Tronoh South	133		–
Cornwall:			
Cornwall Tailings	140		–
Dolcoath	787	92	384
East Pool	1,336	87	532
Geevor	392	–	186
South Crofty	598	62	284
Other Countries:			
Aramayo Francke (Bolivia)	1,816	222	1,073
Briseis (Tasmania)	327	20	124
Deebook (Siam)	398	23	160
Mawchi (Burma)	658	85	380
Porco (Bolivia)	227	21	135
Renong (Siam)	615	91	485
Rooiberg Minerals (Transvaal)	335	10	174
Siamese Tin (Siam)	989	74	338
Tongkah Harbour (Siam)	1,528	104	565
Zaaiplaats (Transvaal)	563	47	302

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	485	417	531	667	678	613
February	469	358	528	646	668	623
March	502	418	547	655	707	606
April	482	444	486	555	584	546
May	480	357	536	509	525	445
June	460	373	510	473	492	423
July	432	455	506	479	545	—
August	228	438	498	551	571	—
September	289	442	535	538	520	—
October	272	511	584	578	491	—
November	283	467	679	621	472	—
December	326	533	654	655	518	—
Total	4,708	5,213	6,594	6,927	6,771	3,256

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
July 1	170¼	£34,035	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	146¼	£33,816	£231 4 6
August 12	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	142½	£28,793	£202 1 2
September 23	145¾	£29,639	£203 7 2
October 7	136½	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	141½	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	166¾	£25,170	£150 19 0
December 16	175½	£26,032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918	4,094	£786,541	£192 0 0
January 13, 1919	160	£20,888	£130 11 0
January 27	135½	£17,000	£125 10 7
February 10	153	£17,441	£113 19 10
February 24	142	£15,015	£105 14 10
March 10	144½	£18,123	£125 8 5
March 24	148½	£17,877	£120 7 8
April 7	134½	£15,258	£111 8 10
April 22	134¼	£15,023	£111 18 1
May 5	129	£14,919	£115 13 2
May 19	126½	£15,844	£125 5 0
June 2	140	£17,185	£122 15 0
June 16	139	£17,206	£123 15 9
June 30	136	£16,782	£123 8 0
July 14	145	£18,250	£125 17 3
July 28	122	£16,939	£138 16 11

Details of Redruth Tin Ticketings.

	July 14 Tons Sold	July 14 Realized per ton £ s. d.	July 28 Tons Sold	July 28 Realized per ton £ s. d.
E. Pool & Agar, No. 1	9	126 17 6	10	139 10 0
,, ,, No. 1a	9	126 17 6	10	137 10 0
,, ,, No. 1b	9	127 5 0	10	137 0 0
,, ,, No. 1c	10	127 5 0	—	—
Dolcoath, No. 1	9	135 7 6	8	144 0 0
,, No. 1a	9	136 5 0	8	145 10 0
,, No. 1b	9	136 12 6	9	145 10 0
,, No. 2	2½	64 2 6	3½	77 15 0
,, A	1½	122 12 6	1½	130 0 0
South Crofty, No. 1	11	128 7 6	11	138 0 0
,, ,, No. 1a	12	128 5 0	11	138 10 0
Grenville Utd., No. 1	8	125 0 0	7	134 10 0
,, ,, No. 1a	7	125 10 0	7	130 10 0
,, ,, No. 2	3	46 0 0	—	—
Tincroft Mines, No. 1	6	133 12 6	5	148 15 0
,, ,, No. 1a	6	134 2 6	6	149 5 0
Levant Mines, No. 1	8	132 12 6	8	144 5 0
,, ,, No. 1a	7	133 15 0	7	145 5 0
Wheal Bellan	1¾	136 0 0	—	—
Hingston Downs	4¼	136 0 0	—	—
Peevor	3	45 0 0	—	—
Total	145		122	

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons. * Figures not published.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January ...	4,395	4,316	3,558	3,149	3,765
February ...	3,780	3,372	2,755	3,191	2,673
March	3,653	3,696	3,286	2,608	2,819
April	3,619	3,177	3,251	3,308	2,855
May	3,823	3,729	3,413	3,332	3,404
June	4,048	3,435	3,489	2,950	2,873
July	3,544	3,517	3,253	3,373	3,756
August	4,046	3,732	3,413	3,259	—
September .	3,932	3,636	3,154	3,166	—
October......	3,797	3,681	3,436	2,870	—
November .	4,059	3,635	3,300	3,131	—
December .	4,071	3,945	3,525	3,023	—
	46,767	43,871	39,833	37,370	22,145

STOCKS OF TIN

Reported by A. Strauss & Co. Long Tons.

	June 30, 1919	July 31, 1919
	Tons	Tons
Straits and Australian Spot	1,816	1,972
Ditto, Landing and in Transit	971	768
Other Standard, Spot and Landing ...	793	544
Straits, Afloat..................................	1,824	1,961
Australian, Afloat.............................	332	252
Banca, on Warrants...........................	—	—
Ditto, Afloat	—	435
Billiton, Spot	—	—
Billiton, Afloat	—	—
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	265	435
Total Afloat for United States...........	25	6,280
Stock in America	182	50
Total	6,208	12,697

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.

Reported by A. Strauss & Co. Long tons.

	June 1919	July 1919
	Tons	Tons
Shipments from:		
Straits to U.K.	1,349	1,562
Straits to America	25	5,305
Straits to Continent.........................	265	435
Straits to Other Places	1,107	2,487
Australia to U.K.	150	100
U.K. to America	—	1,000
Imports of Bolivian Tin into Europe...	1,540	295
Supply:		
Straits	1,639	7,302
Australian	150	100
Billiton	—	—
Banca	572	—
Standard	658	906
Consumption:		
U K, Deliveries..................................	1,375	1,949
Dutch ,, ...	52	102
American ,, ...	68	50
Straits, Banca & Billiton, Continental Ports, etc.	244	290
Straits in hands of Malay Government	—	-
,, controlled by U.S. Government		
,, ,, ,, French and Italian Governments.....		—
Banca in Trading Company's hands ...		733

PRICES OF CHEMICALS. Aug. 9

		£	s.	d
Alum	per ton	17	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous................	per lb.		1	10
,, 0·880 solution	per ton	33	0	0
,, Carbonate	per lb.			6½
,, Chloride of, grey......	per ton	50	0	0
,, ,, ,, pure......	per cwt.	4	0	0
,, Nitrate of	per ton	60	0	0
,, Phosphate of............	,,	114	0	0
,, Sulphate of	,,	17	10	0
Antimony Sulphide	per lb.		1	3
Arsenic, White...........................	per ton	46	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	55	0	0
Bleaching Powder, 35% Cl.	,,	15	0	0
Borax	,,	39	0	0
Copper, Sulphate of	,,	45	0	0
Cyanide of Sodium, 100%.........	per lb.			10
Hydrofluoric Acid	,,			7
Iodine..	,,		14	0
Iron, Sulphate of........................	per ton	5	0	0
Lead, Acetate of, white	,,	85	0	0
,, Nitrate of	,,	56	0	0
,, Oxide of, Litharge	,,	45	0	0
,, White	,,	51	0	0
Lime, Acetate, brown............. .	,,	10	0	0
,, ,, grey 80%............	,,	19	0	0
Magnesite, Calcined	,,	25	0	0
Magnesium Chloride	,,	16	0	0
,, Sulphate................	,,	11	0	0
Methylated Spirit 64° Industrial	per gal.		5	7
Phosphoric Acid	per lb.		1	2
Potassium Bichromate	,,		1	6
,, Carbonate	per ton	85	0	0
,, Chlorate	per lb.		1	1
,, Chloride 80%	per ton	30	0	0
,, Hydrate (Caustic) 90%	,,	160	0	0
,, Nitrate.....................	,,	60	0	0
,, Permanganate	per lb.		3	6
,, Prussiate, Yellow	,,		1	9
,, Sulphate, 90%	per ton	40	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	52	0	0
,, Arsenate 45%..............	,,	48	0	0
,, Bicarbonate	,,	9	10	0
,, Bichromate	per lb.			11
,, Carbonate (Soda Ash)...	per ton	12	0	0
,, ,, (Crystals) ...	,,	4	5	0
,, Chlorate.....................	per lb.			8
,, Hydrate, 76%	per ton	24	0	0
,, Hyposulphite	,,	16	10	0
,, Nitrate, 95%...............	,,	21	0	0
,, Phosphate	,,	25	10	0
,, Prussiate.....................	per lb.			7½
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)......	,,	3	0	0
,, ,, (Glauber's Salts)	,,	3	0	0
,, Sulphide.......................	,,	22	0	0
Sulphur, Roll..............................	,,	21	0	0
,, Flowers..........................	,,	23	0	0
Sulphuric Acid, Non-Arsenical... 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%...	,,	5	0	0
Tartaric Acid.............................	per lb.		2	9
Zinc Chloride	per ton	23	0	0
Zinc Sulphate	,,	22	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:

	Aug. 6, 1918 £ s. d.	Aug. 7, 1919 £ s. d.
Rand:		
Bantjes	3 0	4 0
Brakpan	4 6 3	3 10 0
Central Mining (£8)	6 1 3	9 8 9
Cinderella	4 0	5 0
City & Suburban (£4)	16 3	13 0
City Deep	3 0 6	3 0 0
Consolidated Gold Fields	1 16 3	1 18 9
Consolidated Langlaagte	1 0 0	1 1 0
Consolidated Main Reef	15 0	14 6
Consolidated Mines Selection (10s)	1 7 6	1 5 0
Crown Mines (10s.)	2 6 3	2 7 6
Daggafontein	1 7 6	1 4 9
Durban Roodepoort Deep	10 0	8 9
East Rand Proprietary	3 0	7 0
Ferreira Deep	13 0	13 0
Geduld	1 18 9	2 9 0
Geldenhuis Deep	13 0	11 3
Gov't Gold Mining Areas	4 3 9	4 17 6
Heriot	19 6	13 9
Jupiter	4 6	5 0
Kleinfontein	14 3	13 0
Knight Central	3 6	6 6
Knight's Deep	7 6	9 0
Langlaagte Estate	14 6	1 1 6
Meyer & Charlton	4 17 6	4 18 9
Modderfontein (£4)	24 15 0	27 10 0
Modderfontein B	8 1 3	9 2 6
Modder Deep	7 12 6	8 2 6
Nourse	17 0	14 6
Rand Mines (5s.)	3 2 6	3 1 3
Rand Selection Corporation	4 10 0	3 13 9
Randfontein Central	11 9	13 6
Robinson (£5)	15 6	14 0
Robinson Deep A (1s.)	1 3 9	1 0 0
Rose Deep	19 6	18 9
Simmer & Jack	4 9	5 3
Simmer Deep	3 6	3 0
Springs	3 16 3	2 16 3
Sub-Nigel	1 8 9	1 6 3
Van Ryn	18 0	18 9
Van Ryn Deep	3 15 0	3 17 6
Village Deep	17 6	15 6
Village Main Reef	14 6	13 0
Witwatersrand (Knight's)	1 4 6	1 5 0
Witwatersrand Deep	7 6	13 0
Wolhuter	4 3	4 9
Other Transvaal Gold Mines:		
Glynn's Lydenburg	18 9	1 0 0
Sheba (5s.)	9	1 9
Transvaal Gold Mining Estates	15 3	13 6
Diamonds in South Africa:		
De Beers Deferred (£2 10s.)	15 0 0	24 12 6
Jagersfontein	4 6 3	6 7 6
Premier Deferred (2s. 6d.)	6 15 0	9 5 0
Rhodesia:		
Cam & Motor	12 6	5 6
Chartered British South Africa	17 9	1 2 0
Eldorado	7 0	4 3
Falcon	1 2 6	14 6
Gaika	15 6	16 0
Giant	7 6	7 3
Globe & Phœnix (5s.)	1 10 0	1 4 3
Lonely Reef	1 18 6	2 13 9
Rezende	4 0 0	5 5 0
Shamva	1 19 6	1 17 6
Wanderer (3s.)	1 3	9
Willoughby's (10s.)	5 9	6 3
West Africa:		
Abbontiakoon (10s.)	4 3	5 0
Abosso	7 6	10 6
Ashanti (4s.)	1 0 9	1 2 6
Prestea Block A	4 0	5 9
Taquah	14 9	16 6
West Australia:		
Associated Gold Mines	3 0	4 0
Associated Northern Blocks	2 9	3 9
Bullfinch	1 6	1 6
Golden Horse-Shoe (£5)	2 2 6	1 7 6
Great Boulder Proprietary (2s.)	11 3	9 9
Great Fingall (10s).	2 6	1 9
Ivanhoe (£5)	1 16 3	1 15 [illegible]
Kalgurli	9 0	10 6
Sons of Gwalia	7 9	6 0

Gold, Silver, *cont.*	Aug. 6, 1918 £ s. d.	Aug. 7, 1919 £ s. d.
Others in Australasia:		
Mount Boppy, New South Wales	6 0	9
Talisman, New Zealand	13 0	8 9
Waihi, New Zealand	1 19 0	2 6 3
Waihi Grand Junction, New Z'lnd	16 0	14 0
America:		
Alaska Treadwell (£5), Alaska	10 0	1 12 6
Buena Tierra, Mexico	12 6	18 6
Camp Bird, Colorado	13 9	1 6 3
Casey Cobalt, Ontario	4 0	2 6
El Oro, Mexico	10 9	1 3 6
Esperanza, Mexico	8 0	16 0
Frontino & Bolivia, Colombia	12 6	9 3
Le Roi No. 2 (£5), British Columbia	6 0	11 3
Mexico Mines of El Oro, Mexico	5 12 6	7 0 0
Oroville Dredging, California	18 6	1 10 6
Plymouth Consolidated, California	1 2 6	1 9 0
St. John del Rey, Brazil	17 6	17 6
Santa Gertrudis, Mexico	14 3	1 14 0
Tomboy, Colorado	12 6	16 0
Russia:		
Lena Goldfields	1 7 6	1 10 0
Orsk Priority	14 6	13 9
India:		
Balaghat	4 9	6 0
Champion Reef (2s. 6d.)	5 6	4 6
Mysore (10s.)	2 13 0	2 2 6
North Anantapur	4 0	3 6
Nundydroog (10s.)	1 3 9	17 6
Ooregum (10s.)	18 9	16 0

COPPER:

	Aug. 6, 1918 £ s. d.	Aug. 7, 1919 £ s. d.
Arizona Copper (5s.), Arizona	2 8 9	2 1 3
Cape Copper (£2), Cape Province	2 5 0	2 15 0
Chillagoe (10s.), Queensland	1 0	1 9
Cordoba (5s.), Spain	2 6	1 6
Great Cobar (£5), N.S.W.	2 0	1 6
Hampden Cloncurry, Queensland	1 6 9	1 0 0
Kyshtim, Russia	1 7 6	1 6 3
Messina (5s.), Transvaal	5 0	5 0
Mount Elliott (£5), Queensland	3 5 0	3 10 0
Mount Lyell, Tasmania	1 8 6	1 3 9
Mount Morgan, Queensland	1 14 9	1 5 0
Namaqua (£2), Cape Province	2 0 0	1 15 0
Rio Tinto (£5), Spain	69 0 0	60 0 0
Sissert, Russia	17 6	1 2 6
Spassky, Russia	1 7 6	1 10 0
Tanalyk, Russia	1 8 9	1 12 0
Tanganyika, Congo and Rhodesia	3 17 0	5 0 0
Tharsis (£2), Spain	5 15 0	5 2 6

LEAD-ZINC:

	Aug. 6, 1918 £ s. d.	Aug. 7, 1919 £ s. d.
Broken Hill:		
Amalgamated Zinc	1 7 3	1 5 9
British Broken Hill	2 10 6	1 19 6
Broken Hill Proprietary (8s.)	3 9 9	2 2 6
Broken Hill Block 10 (£10)	1 17 6	1 1 3
Broken Hill North	3 7 0	2 7 0
Broken Hill South	12 15 0	2 2 6*
Sulphide Corporation (15s.)	1 8 0	1 [illegible] 3
Zinc Corporation (10s.)	1 9 3	1 0 6
Asia:		
Burma Corporation	4 10 0	8 17 6
Irtysh Corporation	1 9 9	1 16 3
Russian Mining	13 0	17 6
Russo-Asiatic	3 11 3	3 18 9

TIN:

	Aug. 6, 1918 £ s. d.	Aug. 7, 1919 £ s. d.
Aramayo Francke, Bolivia	2 7 0	3 18 9
Bisichi, Nigeria	15 0	14 0
Briseis, Tasmania	6 0	5 0
Dolcoath, Cornwall	11 3	10 0
East Pool, Cornwall	1 9 0	17 3
Ex-Lands Nigeria (2s.), Nigeria	2 9	2 9
Geevor (10s.) Cornwall	1 4 3	1 0 3
Gopeng, Malay	1 18 9	2 1 3
Ipoh Dredging, Malay	18 0	1 1 0
Malayan Tin Dredging, Malay	2 7 6	2 5 0
Mongu (10s.), Nigeria	15 0	19 6
Naraguta, Nigeria	18 0	17 0
N. N. Bauchi Pref. (10s.), Nigeria	13 0	11 0
,, Ord. (10s.),	8 3	7 0
Pahang Consolidated (5s.), Malay	13 3	15 0
Rayfield, Nigeria	15 9	15 0
Renong Dredging, Siam	2 10 0	2 5 0
Ropp (4s.), Nigeria	1 3 6	1 0 6
Siamese Tin, Siam	3 10 0	3 2 6
South Crofty (5s.), Cornwall	2 11 [illegible]	13 9
Tekka, Malay	4 2 6	4 2 6
Tekka Taiping, Malay	3 17 6	5 7 6
Tronoh, Malay	2 0 0	2 6 3

* Share capital expanded

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

THE NEW ELMORE PROCESS.

The new process invented by F. E. Elmore for dealing with mixed sulphides is described in his patents 6,546 and 11,348 of 1917, consolidated into patent 127,641. The patent has been acquired by the Chemical and Metallurgical Corporation, particulars of which were given in the advertisement columns of the Magazine for June. Details of the process, extracted from the complete specification, are given in the following paragraphs.

This invention relates to the extraction and separation of lead and zinc from ores, concentrates, and the like, in which these metals exist associated together in the form of sulphides. The invention consists in treating the ore, concentrates, or the like with certain acid agents whereby the lead sulphide is converted into a soluble lead compound while the zinc sulphide remains substantially unattacked. The acid agents in question are sulphuric acid alone or a solution of a suitable salt to which has been added either sulphuric acid, hydrochloric acid, or an alkali bisulphate Suitable salts are sodium chloride, ammonium chloride, or other halogen salt (other than that of a heavy metal) capable like these of acting in solution as a solvent of lead sulphate or chloride.

If finely ground galena be heated at about 100°C. with concentrated sulphuric acid (specific gravity about 1·84), the sulphide of lead is converted into sulphate. With proper adjustment of conditions, such as fineness of grinding, proportion of sulphuric acid, temperature, and time of contact, substantially the whole of the sulphide can be converted into sulphate. The latter compound may then be dissolved, for instance in a hot saturated solution of sodium chloride, and thus separated from any insoluble matter. On the other hand, if zinc blende be heated with the concentrated acid at a temperature of about 100°C., only a relatively small amount of the zinc is converted into sulphate, the major portion remaining insoluble in hot brine. If, therefore, the two sulphides be present in an ore or concentrate the lead and zinc may be separated in this manner.

According to one form of the invention the finely ground ore containing the sulphides of lead and zinc is heated with a sufficient quantity of concentrated sulphuric acid at a temperature of about 100°C., until substantially the whole of the lead has been converted into sulphate. The product is washed once or twice with water to remove practically the whole of any remaining free acid, and to the residue is added a hot, strong, preferably saturated solution of sodium chloride. The sulphate of lead dissolves readily in the hot brine and may be separated by filtration, decantation, or otherwise from the undissolved matter containing the zinc sulphide. The hot brine is then cooled, whereupon any excess of lead salt over that which the cooled brine can hold in solution will be precipitated and can be collected for use in any known manner, while the brine is re-heated to be used again. The brine may thus remain in circulation in the process.

Example I.—A lead-zinc sulphide ore from Burma containing 23% of lead and 40·5% of zinc is ground to pass through a 60 mesh standard sieve. Twenty kilos of the powder are mixed with twenty litres of sulphuric acid of 1·84 specific gravity in a lead-lined, steam-heated vessel, and the mixture is heated at about 100°C., until the evolution of sulphur dioxide has practically ceased. Water is now run into the vessel, the mixture well stirred and allowed to settle; the water is run off, and this washing operation once repeated. One hundred litres of a saturated solution of common salt are now run into the vessel, the contents of which are well stirred and maintained at 100°C. for, say half an hour, whereupon the undissolved matter is allowed to settle and the hot solution run into a cooling vat in which a mixture of lead sulphate and chloride separates from the liquid and may be collected for metallurgical treatment. The residue in the heating vessel may be washed first with brine and then with water, if desired, and metallurgically treated for recovery of zinc.

If, instead of sulphuric acid of 1·84 specific gravity, a less concentrated acid be employed, the lead can be converted into lead sulphate, but a larger proportion of the zinc may be in this case converted into zinc sulphate. In deciding whether to use concentrated or weaker acid, practical considerations such as the value of zinc and the cost of the different grades of acid must be taken into account. On using concentrated acid or somewhat weaker acid, the reaction upon the lead sulphide is accompanied by an evolution of sulphur dioxide and the production of free sulphur. With still weaker acids, however, the reaction is accompanied mainly by the evolution of sulphuretted hydrogen. In whatever form sulphur is liberated it may be used in the known manner for producing sulphuric acid. By working separate batches with strong and weaker acids respectively, it is possible, as an alternative to using the sulphur dioxide and sulphuretted hydrogen directly in the known manner for the production of sulphur or sulphuric acid, to lead the sulphur dioxide liberated from the strong-acid batch into the weak-acid batch, whereby the objectionable emission of both sulphur dioxide and sulphuretted hydrogen may be largely abated.

According to another form of the invention, the finely subdivided ore is treated with an acid in presence of a salt, such as sodium chloride. A weaker acid may then be used. Thus, the finely subdivided ore may be treated with hot, strong brine to which sulphuric acid has been added.

Example II.—Twenty kilos of the ore referred to in Example I, crushed to pass through a 100 mesh standard sieve, are stirred in an earthenware steam-heated vessel with one hundred litres of a saturated solution of common salt and the mixture is heated to about 85°C. Six litres of sulphuric acid of 1·84 specific gravity are gradually run into the vessel, the heating being continued. The lead sulphide is attacked, the lead passing into solution, while the zinc sulphide remains substantially insoluble. When the evolution of sulphuretted hydrogen has practically ceased, the hot brine is separated from the insoluble matter and is run into a cooling vat, where it deposits lead salt; it may be re heated to be used again.

When the acid agent is hydrochloric acid in presence of a suitable salt solution, lead chloride is formed and sulphur is evolved in the form of sulphuretted hydrogen.

Example III.—Twenty kilos of the finely subdivided ore referred to in Example I are stirred in an earthenware steam-heated vessel with sixty-five litres of a saturated solution of common salt, the mixture being heated to about 80°C. Eighteen litres of hydrochloric acid of specific gravity 1·11 are now run in, and stirring and heating continued until evolution of sulphuretted hydrogen has practically ceased. After settling, the hot brine is run into a cooling vat where the lead compound crystallizes. The brine may be used again.

Example IV.—Twenty kilos of Broken Hill concentrates containing 44·2% of zinc and 9·2% of lead, and capable of passing through a 30 mesh standard sieve, are mixed in an earthenware steam-heated vessel with 120 litres of a saturated solution of common salt to which 27 kilos of sodium bisulphate ($NaHSO_4$) have been added. The mixture is boiled until the evolution of sulphuretted hydrogen has practically ceased. The hot brine is then separated from the insoluble matter and is run into a cooling vat where it deposits lead salt; it may then be re-heated to be used again

If it is more convenient under local conditions to smelt lead sulphate than lead chloride, it is preferable to convert the latter into sulphate by heating it with strong sulphuric acid, whereby hydrochloric acid gas is evolved; this is absorbed in water or in brine in such manner as to form either a strong aqueous solution of acid or a solution of the acid in brine. The aqueous solution may be mixed with brine to render it suitable for treating a further batch of ore; the solution of the acid in brine is already suitable for this purpose.

The lead sulphate, whether made directly from the ore or from the chloride, may be mixed with lead sulphide and smelted in known manner, and the lead sulphide, or a part of it, necessary for the purpose may be made by utilizing the sulphuretted hydrogen from the treatment of the ore with hydrochloric acid and a salt solution.

The following are the claims:

(1) The treatment of lead-zinc sulphide ores, concentrates, and the like, consisting in treating the ore with an acid agent as herein defined, whereby the lead sulphide is converted into a soluble lead compound while the zinc sulphide remains substantially unattacked.

(2) The treatment of lead-zinc sulphide ores, concentrates, and the like, consisting in heating the ore with strong sulphuric acid at about 100°C. until substantially all the lead sulphide has been converted into lead sulphate, dissolving the latter with a hot strong solution of sodium chloride or other suitable halogen salt, separating the hot solution from the unattacked zinc sulphide, and cooling the solution to cause a partial crystallization of lead salt.

(3) The treatment of lead-zinc sulphide ores, concentrates, and the like, consisting in heating the ore with a strong solution of sodium chloride or other suitable halogen salt to which a sufficient quantity of sulphuric or hydrochloric acid or an alkali bisulphate is added, whereby the lead is caused to pass into solution while the zinc sulphide remains substantially unattacked, separating the hot solution from the zinc sulphide by filtration, decantation, or the like, and cooling the solution to cause a partial crystallization of lead salt.

(4) In the herein described treatment of lead-zinc sulphide ores, concentrates, and the like, for the separation of the lead from the zinc, heating a mixture of one portion of the ore with sulphuric acid of a strength adapted to evolve sulphur dioxide, heating a mixture of another portion of the ore with acid adapted to evolve sulphuretted hydrogen, and passing the gases evolved from the first mixture into the second, substantially as and for the purpose described.

(5) In the herein described treatment of lead-zinc sulphide ores, concentrates, and the like, in which the lead compound produced contains or consists of lead chloride, heating the said compound with strong sulphuric acid and absorbing in water or brine the hydrochloric acid gas evolved, substantially as and for the purpose described.

(6) Smelting the lead sulphate produced by the treatment referred to in Claim (5) with lead sulphide so as to produce metallic lead.

(7) The treatment of lead-zinc sulphide ores, concentrates, and the like, consisting in heating the ore with an acid agent as herein defined, which converts the lead sulphide into a soluble compound while substantially not attacking the zinc sulphide and causes evolution of sulphuretted hydrogen, utilizing the sulphuretted hydrogen to make lead sulphide from the soluble lead compound, and smelting the lead sulphide together with lead sulphate so as to produce metallic lead.

(8) The treatments of lead-zinc sulphide ores described in the several examples herein.

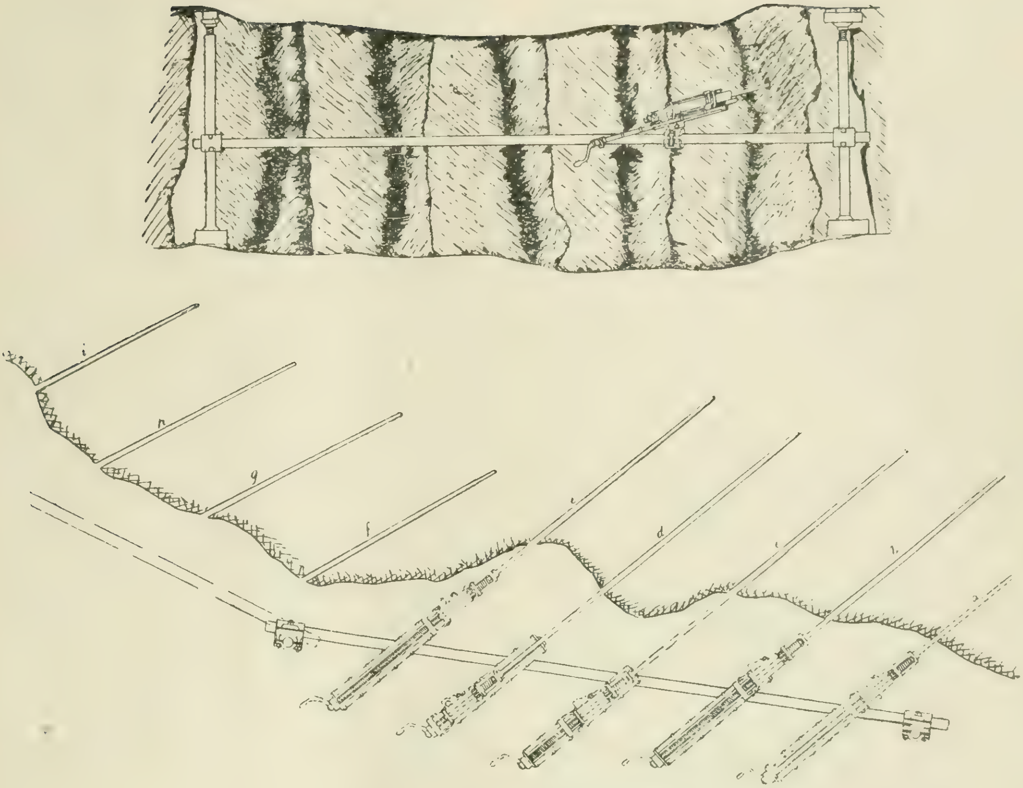
THE "LONG-RIG" IN ROCK-DRILL PRACTICE

At the May meeting of the South African Institution of Engineers, F. C. W. Ingle gave particulars of his "long-rig" system of mounting and operating rock-drills. This information was given as a contribution to the discussion on H. S. Potter's paper on hammer-drills and their history, design, and operation.

The long-rig system is designed to give a support to hammer-drills and to avoid continually rigging up a support. In connection with piston drill work, the system eliminates the multiple-hole bench. When using hammer-drills on this system it is necessary, of course, to have cradles for their support.

The method consists of putting up two bars in the usual way from hanging to foot, about 16 to 18 ft. apart. On to these, and extending past both, is clamped a pipe of suitable size and about 20 ft. in length. This pipe acts as an elongated arm upon which the machine is rigged, and on which it can be moved from bench to bench between the two bars. The holes drilled from this bar are inclined all in the same direction, and the machine moves away from that direction. When all benches lying between the two bars have been drilled over, the bar farthest from the position which the machine will have reached is pulled down and re-rigged on the opposite side of the remaining bar, again at about 18 ft. distance, and the long bar, or pipe, similarly rigged between the two bars. The machine, being placed upon it, drills in continuation. At the end of the shift, the machine and bars are left standing. Only those holes which can be blasted without danger to the machinery are charged and blasted, so that drilling may be continued to the end of the shift, and only a few minutes before lighting up will it be necessary to stop the machine. Again, the machine will be found ready for work as soon as the miner returns to the stope on the following shift. This process is continued until the end of the face is reached, when the machine with its rig will again return to that end of the face from which it originally started.

Several machines may be worked on one face with a suitable interval between them. The necessary length of face will depend upon the nature of the ground. Or



THE "LONG-RIG" SYSTEM OF ROCK-DRILLING.

several machines may be placed on adjoining rigs, the long bars being clamped between a sufficient number of shorter bars. The latter method has the advantage that it permits of closer supervision, and it is easy with this arrangement to utilize advantageously a couple of natives to rig up bars in advance. One disadvantage, however, is that each machine has to be moved a greater distance at the completion of each traverse from bar to bar, and, usually, this entails the removal of hoses to new connections with each change.

The long-rig is in use on the City and Suburban mine with jack-hammers, but is suitable for any type of hammer-drill. When used with jack-hammers, 2 in. bars and 2 in. steam pipe give satisfaction. With piston drills it would be necessary to use 3 in. bars and 3 in. pipe. Up to the present the contractor who has had most experience with the system has used four steels to the set, 2 ft. 6 in., 4 ft., 5 ft. 6 in., and 7 ft. in length, and with gauges $1\frac{3}{4}$ in., $1\frac{9}{16}$ in., $1\frac{3}{8}$ in., $1\frac{3}{16}$ in. respectively.

The face remains comparatively straight; since all the holes are drilled from the long bar, they must terminate at a line which is roughly parallel to the bar. Thus the tendency is to correct any irregularities in the line of the face. The holes, averaging 6 ft. in depth, are drilled at an angle of 45° to the face, and spaced 26 in. apart at their collars. These details will, of course, vary according to the nature of the ground. In this way, although the holes are, to some extent, dependent one upon the other, the failure of one hole hangs up the deeper half of the subsequent one, but the remaining holes will not be affected.

In this stope 67·4 fathoms were broken in April by three jack-hammers, and this was the highest on the mine for all classes of machine stoping. Of the twenty contractors working in the same section of the mine, the next highest fathomage was 55·2.

The chief advantages accruing from the use of this method are as follows: Overhand stoping becomes ideal; there is no rock on the face, the ground being broken away from the face and into the packs; timber is submitted to very little blasting, as it is soon protected by the packs; the dressing down of the ground after blasting is effected without interference with the machines working in the stope; there is no excuse for drilling near a misfire, as, there being no dirt on the face, misfires must be obvious. As pointed out already, there is no loss of time at the beginning and end of the shift in rigging up and pulling down. This is done during the shift as occasion requires, and the average time occupied in rigging up is from fifteen to thirty minutes. Thus drilling starts at the commencement of the shift, and is continued until just before lighting-up time.

The holes are drilled parallel to one another, and the burden must be even along the whole length of the hole. It is thus only necessary to place a mark on the face where each hole is to be collared, and the operator cannot go wrong. The result of these parallel holes and the evenness of burden is that long holes can be used to advantage. As each new stope was started, the ordinary lengths of steel were at first used, but in every case, with the long-rig, it was found advisable to equip with long jumpers, similar to those described above, that is, with 7 ft. chisels. The use of long holes has been justified by the fact that there are very few long sockets left in any of the stopes where they are used.

As the holes are drilled upward, the cuttings fall away, and are immediately sludged, so that the steel has always a clean face to cut. In the initial stages of the trials trouble was caused by the sludge running down the jumper and reaching the chuck, where the escape of compressed air vapourized it. This trouble was overcome by attaching to the jumper, close to the chuck, a 6 in. length of ¾ in. hose, slit down the side and clamped round the steel with a wire spring clip. The sludge drops off as soon as it reaches the greater circumference of the hose. A piece of sacking 9 in. square tied to the chuck so as to overlap the jumper 6 in. is also very effective. Again, when drilling downward with the jack-hammer there is, in crushed ground, a great tendency for jumpers to stick, due to the cuttings being coarse and lodging above the bit on the smaller diameter of the steel. Much time is spent in freeing the jumpers, and quite often it is found impossible to get them out. This trouble has never been experienced when drilling upward. On the contrary, the holes are drilled the quicker in crushed ground.

ACID AND SUPERPHOSPHATE MANUFACTURE AT COCKLE CREEK.

At the Newcastle meeting of the Australasian Institute of Mining Engineers, J. H. McFeeters described the plants for making acid and superphosphate at the works of the Sulphide Corporation at Cockle Creek, New South Wales.

Sulphuric Acid.—Two separate units are in operation, No. 1 plant working on sulphur dioxide generated from pyritic ore, and No. 2 plant working on sulphurous gases obtained from the Huntington-Heberlein desulphurizing process. The latter plant is unique in being the first installation for the successful use of these gases.

The sulphur dioxide for No. 1 plant is obtained by the roasting of pyritic ore in the Herreshoff furnaces. The type of furnace is the new Herreshoff furnace, the special feature of which is an air-cooling device for the rabble arms and central column of the furnace, also enabling control of the temperature of roasting. There are five of these furnaces in this plant. Working on ore of 36% and over of sulphur contents, no further fuel is required after once having been started. As the sulphur dioxide is given off during the process of roasting, it is drawn through dust collectors by the suction created by a lead fan, to be described later. Each furnace has a separate dust collector, which consists of a large rectangular brick chamber, from the top of which are suspended a number of lengths of ½ in. round iron, forming a series of loose curtains through which the gas must pass. The dust drops from these curtains to the bottom of the chamber, from which it is withdrawn from time to time. The gases then unite in a common flue and pass to the Glover tower. The Glover tower, the chief functions of which are denitration, concentration, and cooling, consists of a lead-lined tower 30 ft. high, packed with hard-burnt chemical brick in checker formation. The lead linings of this tower are much heavier than the others of the system, owing to the violence of the chemical reactions taking place therein, and to the temperature of the entering gases, which average about 300°C. The Gay-Lussac towers, the function of which is the absorption of the nitrogen oxides liberated at the end of the process, are two in number, and similar in section, height, and packing to the Glover tower. There are five chambers in this plant, of the following dimensions:

	Height	Width	Length
Nos. 1 and 2	19 ft. 6 in.	25 ft.	97 ft. 6 in.
No. 3.........	18 ft. 6 in.	20 ft.	96 ft.
No. 4.........	19 ft. 6 in.	25 ft.	60 ft.
No. 5.........	19 ft. 6 in.	25 ft.	36 ft.

The curtains and tops of the chambers are built with 7 lb. lead, and the bottoms of 8 lb. They are connected by 26 in. lead pipes with each other and with the towers, one line leading from the Glover tower to the chambers, and the other leading from the last chamber to the Gay-Lussac towers. The lead fan is placed between the Glover tower and the first chamber. The casing and impellers are made of antimonial lead, the impellers being mounted on a 3 in. steel shaft covered with lead sleeves on that part of its length exposed to the acid gases. The fan is belt-driven from a 5 h.p. variable-speed motor, and runs about 240 r.p.m. The gas is drawn from the Herreshoff furnaces through the dust chambers and Glover tower by the suction of the fan, which then forces it through the chambers and Gay-Lussac towers. During the passage of the gas through the chambers, the chemical reactions, resulting in the formation of sulphuric acid, take place, the water necessary to these reactions being supplied in the form of an extremely fine mist by a number of Benker sprays. These reactions are so controlled that the gas issuing from the last chamber contains practically no sulphur dioxide, and only free oxygen and nitrogen oxides. These nitrogen oxides are absorbed by the acid flowing down the Gay-Lussac towers, and are returned to the system by way of the Glover tower. These nitrogen oxides, which hasten the oxidation of sulphur dioxide to sulphur trioxide during the reaction process in the chambers, are originally introduced through the Glover tower in the form of nitric acid.

The No. 2 plant, operating on gases generated by the Huntington-Heberlein desulphurizing process, presents several unusual features; consequently, the design of this plant was modified to meet conditions which might reasonably be anticipated by obtaining gas from such a source. To some extent the plant is practically a combination of both the chamber and tower systems of acid making, and consists of four chambers and seven towers. Of the seven towers in the system there are two Glovers, two inter-chamber towers, one regulator, and two Gay-Lussacs. The Glovers and Gay-Lussacs are rectangular in section, and packed similarly to those of No. 1 set, the former being 25 ft. high and latter 30 ft. Owing to the comparatively low temperature of the gases entering the Glover tower, its function as a concentrator is *nil*, but, by observing several conditions, it still serves its purpose as an efficient denitrator. The inter-chamber towers are 20 ft. high, and also packed with chemical brick. Their chief function is to keep alive rapid chemical reaction by thoroughly mixing the gases, and so minimizing the retarding effect on chemical activity caused by carbon dioxide present as an impurity in the gas. The regulator is similar in design to the inter-chamber towers. It is placed between the last chamber and the Gay-Lussacs. Its chief function is to prevent any sulphur dioxide entering the Gay-Lussacs, a condition which might easily occur when working on gases liable to sudden variations of sulphur dioxide contents. The chambers of this plant are built narrow and high, with the view of decreasing any tendency towards the formation of zones of sluggish gas-movement, and also for being well adapted to the use of water sprays. They are all comparatively short, and, in order to secure the requisite and proportional chamber volume, one to another, the first two are grouped abreast and work in parallel. These two act virtually together as the first chamber of the series. Regarding these two as one, the proportion between the first, second, and third chambers is approximately 4 : 2 : 1. The chamber dimensions are:

	Height	Width	Length
Two chambers in parallel, each	30 ft.	20 ft.	80 ft.
Following chamber	30 ft.	20 ft.	80 ft.
Last chamber	30 ft.	20 ft.	40 ft.

The gases are drawn from the H.H. plant through the dust chambers and Glover tower by the suction of a lead fan, similar in design and position to that of No. 1 plant. In front of the fan these gases divide, a portion going into No. 1 chamber, and a portion into No. 2 chamber, working in parallel; the gas volumes passing into these chambers being controlled by dampers. The issuing gases combine in a 30 in. pipe, common to both chambers, and are forced through the first inter-chamber tower into the following chamber. From here they pass through the next inter-chamber tower into the last chamber, through the regulator, and thence out of the system through the two Gay-Lussac towers, working in series. Attached to this unit is a small sulphur burner, capable of burning three tons per 24 hours. This will be used to supply sulphurous gas whenever the H.H. plant might be closed down for overhaul, or through the closing down of the blast-furnace.

Nitric Acid.—The nitric acid required for use in the Glover tower is manufactured in a 2 ton plant, in a building attached to No. 1 sulphuric acid plant. This particular unit has only recently been installed, and embraces the latest improvements in apparatus for nitric manufacture. Its outstanding features are the unusually large retort and the silica-ware condensers. The plant consists essentially of three principal parts —retort, condensers, and receivers. The retort is cup-shaped, and is set in brickwork. It is fired from beneath, and the flues are so arranged that the hot gases of combustion circle twice round the retort before reaching the chimney stack. Both the retort and its cover are castings, made of special acid-resisting metal known as Narki metal. The condensers consist of a number of 3½ in. pipes, 3 ft. long. The pipes are built up in parallel tiers, having ten pipes in a set. There are four of these sets of condensing tubes working in parallel from a common receptacle. All the pipes are made of fused silica-ware, known as vitreosil, which, besides being acid-proof, withstands sudden changes of temperature. The receivers are three in number, and of 100 gal. capacity each. They are made of acid-resisting stoneware, cylindrical in shape, and 3 ft. in diameter. The retort is charged with two tons of nitrate of soda and the requisite amount of strong sulphuric acid, and a slow fire started in the grate beneath. After some time the liberated nitric begins to distil over. It escapes from the top of the retort through 8 in. vitreosil pipes, which lead to a receptacle, also of vitreosil, communicating both with condensers and receivers. During its passage through these pipes the nitric is condensed, and runs into any one of the three receivers.

Superphosphate.—In theory the process of manufacture of superphosphate is in itself simple. The raw phosphate rock contains phosphoric acid as tribasic phosphate of lime, insoluble in water, and consequently not assimilable by plants. Therefore, the process of manufacture consists in converting this insoluble phosphoric acid into the "water-soluble" or "citrate-soluble" form in which it is available as a plant food. This is done by treating the raw phosphate rock with sulphuric acid, which converts two parts of the lime into gypsum, leaving one part of the lime combined with all the phosphoric acid as the monobasic or water-soluble phosphate of lime. This product is known as "superphosphate," the prefix "super" denoting that the ratio of phosphoric acid to lime is in excess of that of the normal tribasic phosphate. The phosphate rock is imported from the Pacific Islands, the best-known deposits being at Ocean, Makatea, Nauru, and Angaur Islands. They contain a higher percentage of phosphoric acid than any other known deposit, and range from 82% to 87% tribasic phosphate of lime. Cargoes of phosphate rock are unloaded into trucks on the Corporation's wharf at Newcastle, thence by rail to the works at Cockle Creek. These trucks run over the top of the large storage bins, and are there discharged. The present capacity of these bins is 6,000 tons. They will shortly be increased to 10,000 tons capacity. The first step in the manufacture is the crushing of the rock to the degree of fineness which allows rapid reaction between the raw material and sulphuric acid. The rock is first reduced in size by a gyratory crusher, and thence through a series of screens and rolls until a sufficiently fine product is produced. The power for the crushing mill is supplied by two direct-current motors of 75 and 50 h.p. respectively. The finely-crushed rock is elevated from its storage bin to the mixing floor, where it is conveyed by screw conveyors to an automatic weighing machine discharging into the mixer. As the crushed rock runs into the mixer, it also receives a measured quantity of sulphuric acid, with which it is mechanically mixed. The mixers are totally enclosed, and communicate with an exhaust fan, which removes any corrosive gases given off during the decomposition of the rock. When mixed (a process occupying about one minute) the semi-liquid mass is discharged through the bottom of the mixer into reinforced concrete "dens" below. These dens are circular in section, 25 ft. long, and have a capacity of 55 tons. Here chemical reactions between the rock and acid continue, resulting in the semi-liquid material setting to a fairly-solid mass. When set the end and bottom doors of the den are removed, and the superphosphate cut out by a mechanical excavator. As the material is cut out it is carried by belt conveyors and elevated to the "rasper," where drying, granulation, and aeration take place. A definite quantity of clean sand, free from dust, is fed on to the conveyor belt before the superphosphate reaches the rasper, in order to maintain the standard quality or grade, and produces an effective free-drilling fertilizer. From the rasper it is elevated to the conveyor belt running along the top of the storage shed, where a movable tripper permits it to be discharged into any desired section. There are two large storage sheds with a combined storage capacity of 35,000 tons, and the following are the dimensions of the sheds:

No.	Length	Width	Height from floor to ridge cap
1	400 ft.	119 ft.	48 ft.
2	400 ft.	126 ft.	59 ft.

It is in these storage sheds that the final chemical reactions take place, and from which the fully-matured superphosphate is bagged ready for market. The bagging is done by special mills, of which there are three in each shed. The superphosphate from the pile is broken up and loaded on to conveyors or barrows by a mechanical loader. The material is then taken to the bagging mills, where it is screened, the screenings dropping into small storage hoppers. Beneath these hoppers are placed the weighing machines. These machines deliver a set weight only to the sack, and as soon as that weight is attained they automatically cut off the flow of material to the sack. The superphosphate is put up in standard cornsacks, 12 bags weighing one ton. From the bagging mills the superphosphate is loaded for transport into Government trucks placed alongside the platforms attached to each shed.

Besides superphosphate complete, mixed manures are manufactured and marketed. There are two points of special interest about these mixed manures: first, potash is used in varying quantities in the manures, which is now being obtained from burnt seaweed (kelp), coming from works recently established in Tasmania; the second point of interest is that the ammonium sulphate is obtained as a by-product from the power-gas plant.

THE HEIDELBERG GOLDFIELDS.

We conclude herewith our extracts from a series of articles appearing in the *South African Mining and Engineering Journal* dealing with the development of the Heidelberg district and the district to the south of that town. The following notes relate to boring now being done under the auspices of Dr. Hans Sauer and Mr. W. E. Bleloch in the Heidelberg district, and to the work done round Balfour. The illustrating map is given in our June issue.

In the Heidelberg district, three large diamond-drills and a small drill are being employed to test the Town Lands, Boschhoek, and Eendracht properties, and a large amount of trenching and shaft-sinking is proceeding. The deepest bore-hole is on the farm Eendracht No. 267. This hole is being sunk by Dr. Hans Sauer under agreement with the Oceana Company. On this farm the strata may be observed in some clear and well-defined exposures, notably in the vicinity of the Homestead and close to the present diamond-drill site. The quartzitic and sandstone beds are here shown in perfect conformity with a line of strike which is approximately N.E. and S.W. and a dip of about 10° to the N.W. The drill is a Sullivan P. with a capacity to work to a depth of 6,000 ft. Work on the hole was commenced in April of last year and was at first difficult and slow. Latterly, however, excellent progress has been attained, and a few weeks ago a reef series was encountered at a depth of 2,350 ft. The values disclosed were very poor. The section as shown by the cores is as follows: 2,350 ft., banket series; 1 ft. banket; 19 ft., 7 in. quartzite; 2,370 ft. 3 in., 3 ft. banket; 13 in. quartzite; 12 in. reef; 5 ft. quartzite; 2,380 ft. 4 in., conglomerate 4 ft. 4 in. wide, laying on 12 ft. 6 in. of schist and slate. At the time of writing this drill has penetrated to a depth of 2,614 ft. and at that depth was still in quartzite. [In our July issue announcement was made of the suspension of all drilling.—EDITOR.]

Leaving Heidelberg to the north-west and travelling along the Vereeniging Road, one crosses the farm Boschfontein No. 271, the mineral rights of which (as to 3,000 acres) are held by the Boschfontein Gold Mine, Ltd. No work is being done on this property at present, but some years ago a certain amount of development was undertaken at a shallow depth. There is a reef exposed in a cutting alongside this road. This reef, which lies on slate, shows a line of strike approximately N.E. and S.W. and dip to the N.W. Adjoining Boschfontein is Boschhoek No. 270, the property of the Boschhoek Proprietary, Ltd., which has a capital of £360,000. A bore-hole is being sunk here by agreement with Dr. Sauer. The drill is a Sullivan P. machine, and at the time of writing the core was disclosing a fine-grained diabase at 1,226 ft. This diabase is now showing calcite amygdules, and it is thought that from these indications the diabase will soon be penetrated. The drill encountered a bed of slate from 600 to 705 ft. and then entered the diabase. To the north of this hole is the old No. 1 Boschhoek bore-hole which was stopped in dyke at 960 ft. This hole, it is contended, cut the Van Ryn Reef at about 122 ft., but the core was ground and assays were poor. This reef is correlated with the exposure in the cutting alongside the Vereeniging Road on Boschhoek already referred to.

On the eastern side of the town of Heidelberg the Eastern Van Ryn and Modderfontein Gold Reefs, Ltd., is prospecting 1,151 claims, while a further 1,000 claims on the dip of this property have been acquired by Dr. Hans Sauer and may eventually be consolidated into one property. Prospecting on the western portion has been undertaken in a number of shafts and cuttings. In the No. 1 or A working a 12 in. ore-body lying on quartzite with slate underneath with a dip of about 12 was being opened up, and the reef appeared to be widening at the time of the *Journal's* representative's visit In the B workings farther to the east, too, the reef appears to be making. In the C workings the dip is steeper, and farther east again the reef in the D prospect is larger and has yielded 5 dwt. over 24 in. In the next, known as the eastern workings, the reef had been sunk on to a depth of 114 ft., and was yielding 6 dwt. over 4 in. More recently the values disclosed in the prospecting shafts on the reef identified as the Van Ryn have greatly improved. An old bore-hole was sunk on this property some years ago which encountered a reef lying on shale at a depth of 1,943 ft. This reef assayed 11 dwt. over 3 in. and was correlated with the Nigel. Under the present regime a bore-hole was sunk to a depth of 265 ft., but was stopped at this depth, as it was considered to be below the horizon of the Van Ryn series. Another hole has now been placed 1,200 ft. to the south of this, and has reached a depth of 121 ft. It is estimated that in this hole the reef will be encountered somewhere around 1,500 ft. Farther to the east another drill of Sullivan H. pattern has been sunk to 219 ft

Adjoining the Town Lands are the properties of Houtpoort, Ltd. Prospecting and developing work are proceeding on Klippoortje and Tulipvale, and along the railway line to the north-east of Heidelberg a well-developed line of reef, containing a number of black and striped pebbles with schistose enclosures, can be followed for a considerable distance. This outcrop, which runs almost parallel with the railway, is on Klippoortje, where two bore-holes which obtained negative results were put down some years ago. In the vicinity of the No. 6 shaft on the workings of Houtpoort, Ltd., the reef has been broken by an east and west line of faulting, but it has been located again, and in some portions assays of 10 dwt. over 2 ft. of reef are stated to have been obtained. Other workings on this section are styled the Nos. 2, 8, and 9, K. 1, and K 2 prospects. The K. 1 workings got into dyke, and no reef is to be observed in this faulted zone so far. The K. 2 workings have followed the reef down to 37 ft. and at this depth the conglomerate body is shown to be 2 ft. 4½ in. and lying on schist. This reef section has been divided into three portions and has given the following assays: 4 in., 3·4 dwt.; 12½ in., 11 dwt.; 12 in., 2·6 dwt. In the No. 9 workings the reef has given values of 5 dwt. over 4 ft. at a depth of 70 ft

To the south-east of Klippoortje lies Tulipvale, which is also a portion of the Houtpoort property. From the house just inside the fence and gate on the boundary of Tulipvale, a view is to be obtained to a corner of the Nigel mine, while to the west lies Heidelberg. A distance of twelve miles intervenes between Tulipvale and the extremity of Boschfontein, and the greater portion of this ground is held by the Bleloch-Sauer interests. On the northern boundary of Tulipvale, within 120 ft. of the Blesbokspruit and lying direct on slate is a reef 6 ft. 6 in., of which the bottom 6 in. assayed 10 dwt., and the other part 4 dwt. South of Tulipvale is the farm Poortje.

The article proceeds to give an account of the properties with which Mr. Moffat and certain influential capitalists are identified. Reference has already been made to the late Dr. Corstorphine's report for the Platkopies Syndicate on the farms Nooitgedacht (261), Elandsfontein (281), and Platkopie (63), which constitute what may conveniently be termed the Moffat line of country. These farms, together with Koppiesfontein No. 304, lie to the south-west of Heidelberg and cover an extent of country approximating to 14 miles from the southern boundary of Koppiesfontein on the south to the northern part of Nooitgedacht on the north. Leaving Heidelberg to the north-east a drive of about four miles takes one on to Nooitgedacht, just outside the northern boundary of which a typical development of amygdaloidal diabase is to be observed. The greater part of Nooitgedacht is overlain by quartzites and conglomerates of the Upper Witwatersrand formation, but on the eastern portion of this farm the slates, quartzites, and banket beds of the Lower Witwatersrand formation are clearly exposed. There are certain old workings on this farm—workings of the nineties—and it is reported that in one of these prospects a conglomerate body which has been correlated with the Bird Reef was opened up and gave values of 7 dwt. per ton. To the east of Nooitgedacht lies the farm De Hoek No. 68. On the extreme south-western point of this farm a reef has been exposed by trenching. Judging from its geological horizon this reef is the same as that exposed on Nooitgedacht to the north and on Elandsfontein and Platkopie to the south. On the corner of De Hoek the reef is 15 in. wide and dips at a low angle into Nooitgedacht. It is proposed to sink a shaft here at no great distance from the De Hoek fence, with a view to intersecting the reef at a shallow depth.

To the south of Nooitgedacht lies the farm Elandsfontein 281. The valley of the Sugar Bush River cuts through this property, which over its greater part is overlain by the sandstones and coal measures of the Karroo system. On the south-western and north-eastern portions of the farm the Lower and Upper Witwatersrand beds are not overlain by Karroo measures and may be clearly observed. At about the middle of Elandsfontein, the Consolidated Gold Fields of South Africa opened up a reef lying on slate about 25 years ago. This conglomerate body has been correlated with the Nigel Reef, that is the Main Reef Leader according to orthodox geologists. South of Elandsfontein is Platkopie No. 63. The southern and eastern portions of Platkopie are overlain by the amygdaloidal diabase of the Ventersdorp system, but on the western side the Witwatersrand beds are exposed dipping at an angle of about 25° to the west. A good deal of intelligent prospecting work has been carried out here on a reef lying on shale which is to be observed on the boundary of Platkopie and Elandsfontein and which has been exposed in a trench cutting for half a mile. This reef has a shale foot-wall and quartzite hanging, and dips at varying angles of from 15 to 30° to the west. On the Elandsfontein boundary it is at its flattest, but as one proceeds southward the angle of dip increases until a point is reached at about the middle of the farm, where there appears to be considerable faulting, and the whole formation swings around to the east. In so far as the exposures in the trench are concerned, this ore-body exhibits an erratic tendency in regard to width. In places the pebble bed is 15 to 18 in. thick, while in other sections the conglomerates thin down to a mere pebble contact. The values obtained in this trench have ranged from 6 to 8 and 14 dwt. per ton. At the southern extremity of the trench the reef and its accompanying beds manifest signs of faulting. The whole formation appears to have been swung around to the south-east and the line of faulting would seem to be roughly denoted by the line of the spruit to be observed on this portion of the farm. Half-a-mile to the south-east a reef which is in every degree comparable with the conglomerate body referred to in the foregoing, has been exposed in a shaft. This reef lies on what has been termed a mud shale. The shale exhibits silicious amygdules and is regarded as possessing marked characteristics which enable one readily to distinguish it from the shale development underlying the so called Kimberley series of the Upper Witwatersrand system. A shaft sunk on the banket at this point has exposed the reef as a well-developed body of conglomerate. But its erratic character, which seems in many ways to be comparable with the outstanding features of the Nigel Reef as worked in the Nigel mine, appears to be maintained, since on one side of this shaft an assay of 36 dwt. per ton over 2 ft. was obtained, while on the other side values were negligible. To the south-west of this shaft are the sites of the bore-holes put down by the Platkopie Syndicate. These holes were apparently in igneous rock and obtained no results of any value.

Still further to the south is situated Koppiesfontein No. 304, the northern portion of which is covered by the Ventersdorp amygdaloid. As the crow flies it is about 12 miles from the southern boundary of Koppiesfontein to the nearest point on the Vaal River.

A characteristic and consistent geological feature over the greater part of this line of country is the persistent development of a conglomerate body lying on sandstone with a quartzite hanging wall which is separated from amygdaloid diabase (the so-called Bird amygdaloid) by a belt of shale. This particular reef development is correlated with the Bird Reef series of the Central Rand. At numerous points it contains an apparently characteristic chalk pebble and it dips at a flat angle to the west. A distance of about 1,200 ft. separates it from the line of reef opened up by Mr. Moffat. This overlying conglomerate body has been exposed in several small shafts and cuttings on Platkopie. The reef is frequently split into a series of stringers, and at some points assays of 6 dwt. per ton have been obtained, but values appear to be generally erratic. Another prominent feature of this line is the very marked development of a broad shale bed lying about two miles above the horizon of the reef worked by Mr. Moffat. These shales are particularly noticeable at around the Elandsfontein-Platkopie-Schikfontein boundary beacon, where the Sugar Bush River, after flowing through the eastern portion of Mount Arabel, cuts through a very large belt of these shales.

The Moffat properties are now under the control of a company known as the Southern Rand Mines Syndicate, and the intention is to proceed with the initial prospecting of the farms and the proving of the line of reef thereon exposed. The properties have already received the commendation of the late Dr. Corstorphine, and with a view to obtaining further confirmation of Dr. Corstorphine's optimistic views and also obtaining expert advice on the best means of exploiting the auriferous conglomerates, it has just been decided to have the properties reported on by two well-known local mining engineers whose names stand high in the profession. The reports of these gentlemen will be awaited with very considerable interest. In the meantime the *Journal* expresses the opinion that the line of reef taken up by the Southern Rand Mines offers very promising opportunities for the demonstration of a payable extension of the Witwatersrand conglomerates from Heidelberg onwards. The sponsors of the syndicate are not concerned with the dual reef theory. They contend that they have in their properties the extension of the reef worked in the Nigel and Sub Nigel mines, that is to say, they claim to possess the Main Reef Leader of the orthodox school of stratigraphists. This claim has been supported by Dr. Corstorphine. The syndicate is not engaged in the prospecting of a line of grit or grit contact as has been alleged by a member of the heterodox faith. The reef exposed on the properties referred to in the foregoing is a true conglomerate. It would appear to be a comparatively thin ore body and to have certain erratic characteristics both as regards width and gold content. But it is as much a conglomerate as the Main Reef Leader or South Reef of the Central Rand. Moreover, it is an auriferous conglomerate; it contains gold and at numerous points along the line of prospecting it contains gold in payable quantities.

The town of Balfour (previously termed McHattiesburg and Vlakfontein) lies about 17 miles as the crow flies to the south-east of Heidelberg. The township is on the main Natal railway line and is the centre of a prosperous agricultural community. A small branch line forks off from Balfour to the Grootvlei Collieries, and it is reported that the Railway Administration has the construction of another line to the Free State in view. This branch line would traverse one of the most fertile areas of the Transvaal, and the future of Balfour as a centre of agricultural industry is assured. But there are also most unmistakable evidences of mineral wealth in this region, and it will not be surprising if Balfour becomes the centre of a flourishing outpost of the gold-mining industry within the next few years. This area, in common with most of the other sections of the Greater Heidelberg goldfields, has been extensively prospected in the past, but it does not appear that the main geological features of this field were appreciated until recently. The Witwatersrand beds occur in the Balfour area in the form of an outlying basin, of which the southern rim is now being prospected along the line of the farms Malanskraal No. 73, Driefontein No. 280, Tweefontein No. 98, Rietfontein No. 244, Wilgepoort No. 244, and Daspoort No. 120 A complete section of the Lower and Upper Witwatersrand beds in their proper and ordered sequence forms an outstanding and favourable feature of this area. The section from the basal granite up to the Elsburg beds, which can be clearly observed in this locality, is in every degree comparable with a section through the heart of the rich Far East Rand area, across the stratigraphical line on which the great Modderfontein mines are working. The completeness and sequence of the various formations which make up this section have impressed a number of leading geologists and engineers most favourably. The only striking difference to be noted between a section across the Malanskraal-Wilgepoort line and a section across the Far East Rand is a difference in the thickness of the beds. This difference would account for mistakes which have been made in the past in prospecting this section of the country.

The most prominent reefs outcropping on Wilgepoort are the Kimberley reef group, which reefs attain in places great widths, from 20 to 30 ft., and generally pan gold. There are eight banket beds in this series within 200 ft., and two more some 500 ft. on the dip. Where the Kimberley shales outcrop, their banded structure attracts the eye. It was on the Kimberley group that most work was done in this area in the past, it being taken for Main Reef series from the early days of the goldfields by prospectors and mining engineers. Numerous shafts have been sunk on the different reefs, and a number of bore-holes have cut the reefs in depth, showing most encouraging values. On Wilgepoort a bore-hole under the direction of the late Dr. Carrick and Mr. J. G. Hoffmann cut two reefs, one at 908 ft., 15 in wide, assaying 11½ dwt., and one at 953 ft., 30½ in. wide, assaying 6¾ dwt. On Daspoort a bore-hole put down under the direction of J. H. Davies also cut two reefs, one at 2,024 ft., 17½ in. wide, assaying 15·4 dwt., and one at 2,464 ft., 30 in. wide, assaying 7·83 dwt. This latter bore hole was carried down to 2,715 ft., where it cut a shale bed. On the lower beds a lot of shafts and bore-holes have tested the shale-sandstone contacts looking for the Nigel Reef, and a small pebble banket reef from 12 to 30 in. wide is very persistent along this line. The attenuation of the strata and the prominent development of the so-called Kimberley series appear, however, to have misled the earlier searchers after a payable extension of the Far East Rand goldfields in this outlying area. The late Laurie Hamilton directed a considerable amount of work on two big pebble reefs which are now ascribed to Kimberley horizon, and in places he appears to have encountered good values, assays as high as 35 dwt. over 6 in. having been obtained along this line.

Proceeding from west to east, the line of strike of the formation appears to be east and west through Malanskraal, Driefontein, and Tweefontein, the dip being to the north. Across Wilgepoort the formation runs with a N.W.-S.E line of strike and a dip to the north-east in undisturbed country, and thereafter this line is maintained on Daspoort, although on this latter farm there are evidences of faulting and a substantial displacement of strata. To the east and south of Daspoort the formation is overlain by Karroo measures which are being worked on Grootvlei by the South Rand Exploration Company's colliery. Leaving Balfour, a short drive to the south takes one to the line of banded ferruginous slates (often contorted and magnetic) which so remarkedly resemble the Hospital Hill slates of the Central Rand, a characteristic formation, the value of which as a marker geologists are all agreed on. Traversing the formation from this horizon one cannot fail to be impressed with the ordered sequence of the various beds and their unmistakable similarity to a typical section across the Far East Rand At several points along this line trenches and cuttings have exposed reef formation and in some places shafts and diamond-drill holes have penetrated to a substantial depth.

But it is not until one has crossed the big vlei on the southern portion of Wilgepoort that important work is to be observed. From the vlei the ground rises fairly steeply up to the line of kopjes, below which the prospecting camp of the Far East Rand South Company is located. This company, which has a nominal capital of £75,000 in ten shillings shares, is styled the Far East Rand (South) Gold Mines Selections, Ltd. (to give it its full title), owns 500 claims on Wilgepoort No. 244, and has been quietly prospecting this property for some months past under the management of J. A. Thorburn. The claims held run for about two miles along the outcrop, and the depth of the area is from six to ten claims on the dip. A great deal of intelligent work has been done here along a line of reefs lying immediately to the south of the prospecting camp. After all the failures of the earlier days it remained for the late Dr. Carrick and J. G. Hoffmann and the late Laurie Hamilton to divert prospecting work on to the line at present under exploitation. Their efforts resulted in the opening up of two banket reefs which were reported as being "40 ft. and 120 ft. away from the shale contact."

The reefs, A and B, which are now being developed are correlative to the reefs of the great mines of the Far East Rand. This view is held by a number of prominent geologists and mining engineers, so that the Far East Rand (South) Company has plenty of stratigraphical justification for prosecuting work on its property. The series containing the A and B Reefs exhibit a dip of about 30° to the north-east and the whole reef section shows a thickness of 4 ft. 6 in. with a bastard foot-wall. In this respect the section exhibits a striking stratigraphical similarity to a section of the May Consolidated mine. The reefs have been opened up for a distance of 5,000 ft., while one shaft had, at the time of the *Journal's* visit, been sunk to a depth of 100 ft. and another shaft on the South Reef to a depth of 70 ft. In each of these shafts the reef is showing as a strong and well-defined ore-body, and it would be well if the company was in possession of sufficient working capital to demonstrate the existence or non-existence on Wilgepoort of large pay shoots similar to those worked on the Far East Rand. More important from the commercial point of view than the geological aspect is the question of the gold contents. In this respect the company is favourably circumstanced. The latest development gives assays as follows: No. 1 shaft at 150 ft.: Sample No. 1 over 25 in., 12·2 dwt.; sample No. 2 over 14 in., 12·3 dwt.; sample No. 3 over 14 in., 9·3 dwt.; sample No. 4 over 25 in., 6·6 dwt. Drive (west): Sample No. 5 over 12 in 21·4 dwt. Good results have also been obtained on the ground of the Wilgepoort Syndicate adjoining the Far East Rand (South) property and also on Malanskraal, where a large ore-body which is correlated with the A Reef worked on the Wilgepoort Farm has been opened up.

Geology of Southern Nigeria. — At the meeting of the Geological Society held on June 25, A. E. Kitson, director of the Geological Survey of the Gold Coast, gave a lecture on the geology of Southern Nigeria, with special reference to the Tertiary deposits. The oldest rocks in Southern Nigeria comprise a series of quartzites, schists of various kinds, blue and white marble, grey limestones, altered tuffs and lavas, amphibolites, and gneisses. Their strike varies from west-north-west and east-south-east to north-east and south-west. They occur in the north-western portion of the country (Yorubaland), north of lat. 7° N., and in Oban-Hills region in the east. They may be classed provisionally as Pre-Cambrian. Intruded into these are large masses of granites of various kinds, syenite and diorite, with pegmatite dykes and aplite dykes. In some parts these rocks have shared in the dynamic alteration to which the oldest series has been subjected; but usually they are practically unchanged. There is no definite evidence to show to what period they belong, but they are certainly Pre-Cretaceous, probably Middle and Early Palæozoic. So far as observed, there is a great hiatus between the Pre-Cambrian and the next known sediments, the Upper Cretaceous. Normally, these are slightly inclined rocks. They include: (1) marine fossiliferous shales, mudstones, limestones, and sandstones in the great valley between the Oban Hills and the Udi plateau, the fossils being principally ammonites and mollusca; (2) estuarine fossiliferous carbonaceous shales, mudstones, and sandstones along the eastern foot of the Udi escarpment; (3) lacustrine sandstones, shales, and black coal-seams, with numerous plant-remains; and (4) fluvio-lacustrine sands, shales, and pebble-bands in the lower and upper parts of the Udi plateau. Flanking this plateau on the south and south-east, and extending thence over the southern part of the great valley to the Cross River, is a series of Eocene estuarine shales, clays, and marls, with septarian nodules and pieces of coal and resin, and a rich fauna consisting principally of mollusca, but including fragmentary remains of whales, birds, fishes, and turtles. A thick series of sandstones, mudstones, shales, and seams of brown coal forms a large portion of the basin of the Niger, west of the Udi plateau. These rocks appear to be of lacustrine origin, and are probably Eocene. They contain numerous remains of undetermined plants, largely of dicotyledonous types. Their relation to the Cretaceous and to the Eocene estuarine series is uncertain. In the Ijebu Jebu district are bituminiferous sands and clays with Pliocene estuarine shells. Extending over practically the whole of the country south of lat. 7° 10′ N., and west of the great valley of the marine Cretaceous is a varying thickness of (usually unstratified) clayey sands, probably late Pliocene, the Benin Sands Series of J. Parkinson. Along the coast-line and extending for considerable distances up the Niger and Cross Rivers are fluviatile, deltaic, littoral, and swamp gravels, sands, and muds of Pleistocene and recent age. In the Cross River basin, intruded into the marine Cretaceous, are volcanic necks of decomposed agglomerate, and sills (?) and dykes of olivine-dolerite. These are probably Pre-Eocene. Faulting and local folding are visible in various portions of this district. Numerous silver-lead-zinc-iron lodes occur along these fault-lines, with brine-springs in several localities. The Yorubaland crystalline rocks contain magnetite in considerable quantities, while these and the crystalline rocks of the Oban Hills show smaller quantities of cassiterite, gold, monazite, and columbite

In reply to questions, Mr. Kitson said that private boring reports stated that gas, oil, and bitumen, also shell and lignite, had been obtained in bores along the Awni River, at depths of from 630 to 750 ft. He himself had seen some of this heavy oil and fossiliferous clayey sand, etc., and had noted that the latter contained many foraminifera and fragments of mollusca. From the general character of the fossils he regarded them tentatively as Older Tertiary. The Orbitoidal limestone to which reference had been made had been determined by R. B. Newton as Eocene. In the Awni district these Tertiary deposits rest directly on crystalline rocks. Farther east Upper Cretaceous beds apparently supervene between them and the crystalline series, for from the material which Mr. Parkinson had obtained from one bore (locality not given) Mr. Newton had identified an Upper Cretaceous Pelecypod. This links the containing deposit with those of the Cross-River region in the east of the Colony. No Miocene or Oligocene deposits have been observed in the Ijebu district. There is no definite evidence regarding the age of the Brown Coal Series. Lithologically the beds are less compact than those of the lascustrine and estuarine Upper Cretaceous, and so far as seen the plants are predominantly of dicotyledonous types, whereas those of the Upper Cretaceous show few of these types. No correlation by the aid of the contained heavy minerals of the coarser beds has been made of the Tertiary deposits, for all the concentrates from such beds contain all or most of the characteristic minerals of crystalline rocks: such as zircon, magnetite, ilmenite, rutile, tourmaline, staurolite, felspar, monazite, and kyanite.

Low-Grade Nickel Ores.—The *Journal of Industrial and Engineering Chemistry* for July contains a paper by C. W. Davis describing experiments on the treatment of low-grade nickel ore from Webster, North Carolina, and Chichagof Island, Alaska. The North Carolina ore is a silicate associated with much iron, and averaging 1% nickel. The Alaska ore is a mixture of pyrite, chalcopyrite, and pentlandite, running 3·7 nickel and 4% copper.

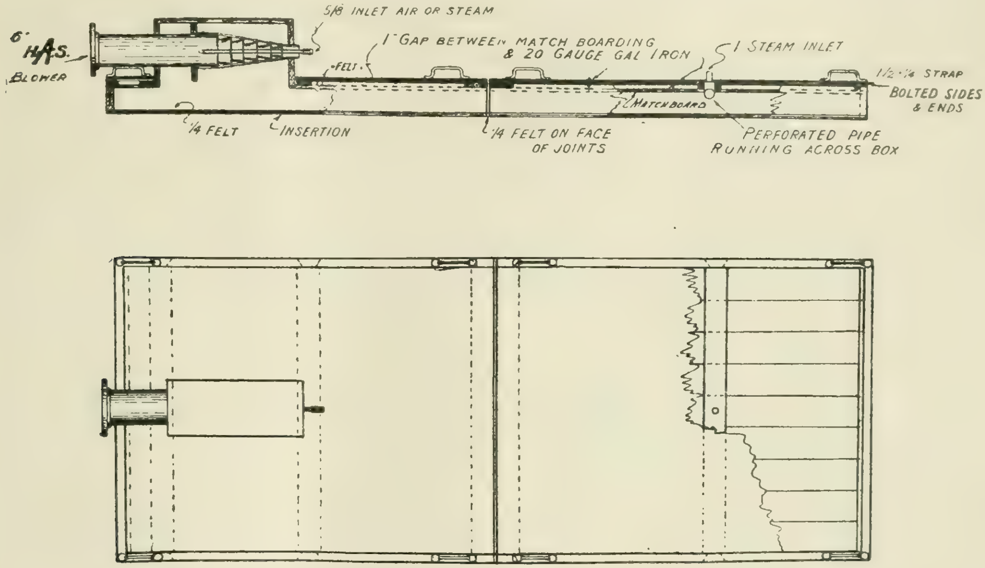
No satisfactory concentration of the ores was obtained by sizing tests, panning, tabling, magnetic concentration, or flotation. Magnetic treatment of the reduced North Carolina ore brought the concentration of nickel from 0·97% to 3·6%, the recovery being 45%. An excess of concentrated nitric acid or aqua regia extracted the nickel from the finely ground ores by hot digestion. Other solvents in large excess dissolved only part of the nickel. Hot, dilute sulphuric acid (2%) in excess extracted the nickel from the ores which had been reduced with water gas at 1,000°C. A large excess, however, was required to react with the iron present before much of the nickel was attacked. The nickel in the reduced ores was largely extracted with an excessive amount of ferric sulphate solution. No state of oxidation was found at which the nickel was soluble in dilute acid without having the iron soluble also. The best extracton of nickel as the chloride from the North Carolina ore was, with water, 10%, and with 1% acid, 37%. The acid requirement is nearly the same as that for the extraction of nickel from untreated ore. By mixing the North Carolina ore with an excess of salt and sulphur, and heating for some time at 1,000°C., it was found possible to volatilize 50% of the nickel as the chloride. A sulphide roast of the North Carolina ore followed by a treatment with dilute sulphuric acid gave an extraction of about 70%; the consumption, however, was prohibitive. By fusing the reduced North Carolina ore with an equal weight of nitre cake, 90% of the nickel was rendered water-soluble; with one-half as much nitre cake as ore, only 60% was water-soluble. The quantity of nitre cake required for the extraction of the nickel from roasted and reduced Alaska ore varied with the nickel content; the ratio of the ore to sodium bisulphate was, for a 2·3% ore, 1 to 1; for a 3 to 4% ore, 2 to 3; and for an 8 to 11% ore, 1 to 3. The best temperature for the nitre cake roast was 500°C. Thirty minutes was sufficient for the fusion of small quantities of reduced ore with nitre cake. By treating the Alaska nickel ore with an equal weight of nitric acid (70%), and heating for 2 hours at 250°C., 95% of the nickel was made water-soluble, while all but 1·2% of the nitric acid was driven off. Most of this acid could be recovered by absorption.

Results obtained from the work on the low-grade nickel ore from North Carolina indicate that it cannot be profitably treated with the chemical market as it is at present; but that a silicate ore even of as low grade as the ore examined might be economically worked, if of low iron content, by reduction and subsequent leaching with dilute sulphuric acid. With a favourable price for quantities of nitre cake, the sulphide ore from Alaska might be treated for the removal of nickel by roasting the tails from the copper flotation separation free from sulphur, reducing with charcoal, roasting with nitre cake, and extracting with water, the nickel to be recovered electrolytically or by precipitation with lime after the removal of iron by means of calcium carbonate. The complexity of this treatment would be an important factor in determining whether the process could be used. The Alaska ore might be treated with nitric acid, heated to remove most of the oxides of nitrogen, and the nickel extracted with water, the nitric acid being recovered by water absorption. The quantity of nitrc acid recovered on large runs would largely determine the availability of this treatment.

Queensland Wolfram.—The *Queensland Government Mining Journal* for May contains a brief account, written by the manager, F. C. Cann, of the mines and mill at Wolfram Camp and Mount Carbine developed by the Thermo-Electric Reduction Corporation, and now belonging to the Burma Queensland Corporation. A general outline of the dressing plant at Wolfram Camp is as follows: The ore gravitates to a grizzley with 1·5 in. openings, the oversize falling into No. 1 jaw-breaker, set to break at 3 in. guage. The ore from this breaker falls on a second grizzley, the undersize joining the undersize from the first grizzley, and the oversize falling into No. 2 jaw-breaker, set to break at 1·5 in. gauge. The product from No. 2 jaw-breaker joins with the former products, gravitates to a storage bin, and is then conveyed to the mill bin. From the mill bin the ore is fed to stamps. The stamp screens are of steel wire, $\frac{3}{32}$ in. aperture. The pulp from the stamps is automatically sampled as it passes to hydraulic classifiers. The spigot discharge from the classifiers go to jigs, and the overflow to settlers. The jigs have three hutches. The products from Nos. 1, 2, and 3 hutches are fed separately on Wilfley tables, and the jig tails on to Buss tables. The middlings from the tables go to grinding pans, and the tailings from the tables to dewaterers. The spigot of these dewaterers passes to the flotation plant, and the product from the grinding pans goes to a second group of classifiers. The spigots of these classifiers are fed on high-speed reciprocating tables. Middlings from these tables are elevated to grinding pans, the tails joining the tails from the Wilfley and Buss tables, and passing to flotation plant. The spigot of No. 1 group of settlers joins the overflow from No. 2 group of classifiers, and passes to classifiers of No. 3 group. The spigot of these classifiers feeds Isbell vanners, and the tails from the vanners go to flotation plant. The overflow from the No. 1 group of settlers joins the overflow from No. 3 group of classifiers, and passes to large settlers, the spigot of these settlers feeding slime frames. The tailings from the slime tables join the tailings from the vanners, and are treated in a flotation plant separate from the flotation plant treating the tails from the tables. The water-concentration plant produces wolfram and bismuth concentrate and the flotation plant molybdenite concentrate. The whole of the machinery is worked by electric motors, and the works are lighted by electricity throughout. The generating plant is situated alongside the mill, and when completed will consist of four Diesel engines (of which two are already erected) of 200 b.h.p. each, and coupled direct to alternate current generators. Storage tanks for fuel oil have been erected at Cairns and Dimbulah, and also alongside the power-station. The oil is pumped into tanks on railway wagons at Cairns, and conveyed to Dimbulah; then pumped into storage tanks at Dimbulah, and when required pumped into tanks on road-wagons and conveyed to the power-station storage tanks.

Amalgamating.—The May *Journal* of the Chemical, Metallurgical & Mining Society of South Africa contains the report of a discussion on the prevention of the escape of mercurial fumes during the steaming of amalgamating plates.

J. Fairfax Walker described the apparatus used for preventing their escape at the plant of Consolidated Main Reef. The old method of steaming plates, common to most mines, is to have a wooden box, or cover, placed over the amalgamated plate, with the usual inlet of steam. The sides are jammed with sacks, or blanketting, with a view to retaining all the steam. The result is that, except in the well-ventilated plate-houses, mercury-laden steam pervades the building. When the steaming cover is removed, the conditions are even worse, as the workmen have to handle steaming sacks and steam is still present under the cover. The new device adopted to combat these conditions consists for a 12 by 5 ft. table of a clamped-down cover made in two sections. The top of the cover is made of 20 gauge galvanized iron, bolted on to a wooden frame, on the bottom of which is tacked thick Kafir blanket, horse rug, or any such material. This cover is placed on the plate with four pieces of angle or channel iron, two for each section of the cover. Hook bolts are fixed to the frame below the plate, and the screw portion is slipped into slots in the angle iron and fastened down with fly nuts. This makes a tight joint between cover and plate. A 1 in. steam connection is fixed to the top section of the cover, passes inside, and spreads over the full width of the plate by means of a perforated pipe. A pressure of from 5 to 10 lb. is maintained. The steam is drawn off through a chamber, tapering in diameter from 11 to 4 in., by means of a canvas hose 5 in. in diameter. A 1 in. spiral wire is run inside the hose to stiffen it, and the outside is given two coats of oil paint to make it steam-tight. The fumes are exhausted through the roof by an induction fan which, on this plant, is placed outside the building. An air or steam ejector has been found a satisfactory substitute for the fan. The method of operation is as follows: The fan, or ejector, is started and steam turned on at from 5 to 10 lb. pressure for the required time, 10 to 15 minutes, after which the steam is turned off, the flexible steam pipe disconnected, hook bolts and angle iron stays taken adrift, and a water drain pipe plug at bottom end of cover taken out. The fan, or ejector, is kept going until all the fumes are eliminated, and then the top section of the cover is raised ½ in. for two or three minutes to allow fresh air to enter under the cover and drive out the last of the fumes. Lastly, the flexible hose-pipe is disconnected from the cover. When the latter is removed there is not a trace of fume to be seen, the atmosphere being quite clear and sweet. The advantages of the device are: first and foremost, safeguarding the health of the men operating on steaming amalgamated plates; secondly, the amount of steam used is much less than formerly, owing to its being evenly distributed all over the plate and concentrated under cover; thirdly, the fixing of the device and steaming of the plate are done in less time than by the old method. The cost of operating is small, while the cost of installation is not great. On this plant the cost of installing all but the fan was under £100.



Steaming Amalgamating Plates at Consolidated Main Reef.

J. J. Smythe then described a simpler apparatus employed at the Village Main Reef. It was considered that under existing circumstances the Village Main Reef was not justified in going to the expense of such an elaborate plant as that on the Consolidated Main Reef. The steaming box and mercury fume extractor at Village Main Reef was devised to do away with an expensive installation of piping and a power-driven fan for exhausting the steam. The apparatus consists of an ordinary steaming box with a patent 6 in. H.A.S blower fitted to the lower end of the bottom half of the box and open to the interior. This blower has a nozzle of ⅛ in. diameter, and consumes at 80 lb. pressure 21·2 cub. ft. of free air per minute. In operation it is only necessary to turn on sufficient air to cause a vacuum strong enough to prevent steam leaking from bad joints caused by irregularities of the surface of the amalgamated plates, and full on for a few seconds when steam is turned off from the box in order to clear out any remaining vapour. Where air is unobtainable.

steam can be used in the blower. The whole operation of steaming one plate should not cost in air consumption more than one penny, if as much. At the Village Main Reef a short piece of pipe, 8 ft. long, joined on to the blower carries the steam outside the building containing the plants and exhausts to atmosphere. Contact between the box and plate is made by sufficiently weighting them down with movable weights. No attempt has been made here to condense the steam from the box and so recover mercury carried off, it being understood the quantity is too small for it to prove a commercial success in view of the cost of providing and running a condensing plant. As a result of the experience with the 6 in. blower it is considered that a 4 in. would be ample to do the work, and thereby save in weight and cost as follows: 6 in. blower, approximate cost, £12, approximate weight, 33 lb.; 4 in. blower, approximate cost, £10, approximate weight, 22 lb.

Oolitic Ironstones.—At the meeting of the Mineralogical Society held on June 17, R. H. Rastall read a paper on the mineral composition of oolitic limestones. In many oolitic ironstones the ooliths contain more iron or are more highly oxidized than the matrix. Assuming that the iron-content of such rocks is introduced by metasomatic replacement of calcium carbonate, this may be explained iu the following way: Many ooliths and organic fragments in limestones consist of aragonite, while the cement is calcite. Aragonite is less stable than calcite and more readily decomposed by iron-bearing solutions, which therefore attack the aragonite first, while the calcite is replaced later. Hence we have the following scheme, in successive stages:

	(a)	(b)	(c)
ooliths	aragonite →	chalybite →	limonite
matrix	calcite	calcite	→ chalybite

The ooliths are thus always a stage ahead of the matrix in replacement and oxidation. The origin of the green iron silicate, found in many ironstones, requires further investigation.

SHORT NOTICES

Concrete Shafts.—In the *Engineering and Mining Journal* for July 12, R. L. Russell describes the sinking and simultaneous concreting of a shaft at the Miami copper mine, Arizona.

Electric Hoists.—In the *Mining and Scientific Press* for July 5, O. E. Jager describes the electric hoisting equipment at the Butte & Superior mine.

Electric Drills.—The *Iron & Coal Trades Review* for July 18 contains a paper by A. H. Telfer, read before the Association of Mining Electrical Engineers, describing the Crescent and Becander electrically-operated rotary drills intended for boring coal.

Gold in China.—In the *Engineering and Mining Journal* for June 21, H. K. Richardson describes gold-washing operations on the Yang-tse-kiang in Sze-chuan province.

Dredge for Colombia.—The *Engineer* for July 25 gives an illustrated description of the bucket-dredge designed by Inder, Henderson, & Dixon, and made by Lobnitz & Co., for the treatment of gold-platinum deposits in Colombia.

Oil Mining.—In the *Engineering and Mining Journal* for July 5, S. S. Langley describes the methods of sealing off water from oil wells.

Concentration. — The *Engineering and Mining Journal* for June 28 is the "annual milling number" and contains a number of articles on comminution, water-concentration, and flotation

Magnetic Separation. — In the *Engineering and Mining Journal* for June 28, G. J. Young writes on working adjustments of the Wetherill magnetic separator.

Magnetic Separation.—In the *Engineering and Mining Journal* for June 28, E. G. Deutman describes the concentration practice in the Wisconsin zinc district. The blende is associated with iron sulphide in the form of marcasite. The concentrate is given a a roast which covers the marcasite with magnetic oxide but does not affect the blende. The two minerals are then separated magnetically

Refining Graphite.—The *Engineering and Mining Journal* for July 12 contains a paper by F. G. Moses on the refining of Alabama graphite and the production of a material suitable for crucible manufacture.

Lake Superior Copper.—In the *Engineering and Mining Journal* for July 5, C. H. Benedict, metallurgist to the Calumet & Hecla, writes on recent advances in ore-treatment practice at the copper mines of Lake Superior.

Shasta County, California.—In the *Mining and Scientific Press* for June 14, Herbert Lang continues his paper entitled "A Metallurgical Journey to Shasta, California." This instalment deals with early cyaniding and chlorination.

Sintering.—In *Chemical and Metallurgical Engineering* for June 15, R. M. Draper describes the sintering or nodulizing of fine flotation concentrate in rotary kilns using pulverized coal.

Zinc Smelting.—In *Chemical and Metallurgical Engineering* for June 15, R. S. Dean discusses the prevention of the formation of blue powder in the smelting of zinc, and the reason why salt added to the charge is effective in this prevention

Treatment of Speiss.—*Chemical and Metallurgical Engineering* for July 1 contains a translation of a paper by P. Papencordt appearing in a recent issue of *Metall und Erz* describing research in connection with the metallurgical treatment of complex speisses.

Powdered Coal in Blast-Furnaces.—The July *Bulletin* of the Canadian Mining Institute contains a paper by E. P. Mathewson and W. L. Wotherspoon on the Garred-Cavers method of using pulverized coal in blast-furnaces treating copper ores. In particular, details of practice on the Sudbury copper-nickel ores at the works of the International Nickel Company, Copper Cliff, Ontario, are given. We intend to quote from this paper in our next issue

Cement from Blast-Furnace Slag.—The *Queensland Government Mining Journal* for April contains a paper by William Poole on the manufacture of cement from blast-furnace slag, based on studies at the iron blast-furnaces at Newcastle and Lithgow, New South Wales.

Copper in Arctic Canada.—The *Mining and Scientific Press* for June 14 publishes a paper by J. J. O'Neill describing the occurrence of native copper in Arctic Canada. In our issue of May, 1917, we quoted Mr. O'Neill's paper on the subject that appeared in the March *Bulletin* of the Canadian Mining Institute

Burma Geology.—The *Journal of Geology* for May contains a paper by M. H. Loveman, giving the results of his investigations of the geology of certain parts of the Northern Shan States, Burma, not previously mapped.

Wasapika, Ontario.—In the *Canadian Mining Journal* for July 9, Reginald E. Hore describes the Wasapika gold area in West Shining Tree district, Ontario.

Chrome in Maryland.—In *Economic Geology* for May, J. T. Singewald describes the Maryland chrome ore deposits. In early days these ores were of great importance. Since 1880 the output has been confined to concentrate from chromite-bearing sand.

Queensland Coal. — The Australasian Institute of Mining Engineers' Proceedings No. 32 contains a paper by J. F. Hall describing the Blair Athol coalfield, central Queensland, 240 miles by rail from Rockhampton.

Wonthaggi Coalfield.—The Australasian Institute of Mining Engineers' Proceedings No. 32 contains a paper by H. Herman on boring operations at the Wonthaggi coalfield.

Phosphate in Victoria.—The Australasian Institute of Mining Engineers' Proceedings No. 32 contains a paper by E. W. Skeats and E. O. Teale describing newly discovered phosphate deposits in the Howqua district, near Mansfield, Victoria.

Oil in England.—In the *Iron & Coal Trades Review* for July 25, J. Ford discusses the oil occurrences in Derbyshire and Nottinghamshire, dealing specially with the results of the bore at Kelham, near Newark.

RECENT PATENTS PUBLISHED.

11,643 of 1917 (128,623). E. B. MAXTED and T. A. SMITH, Walsall. Furnace for producing ammonia from nitrogen and hydrogen under pressure.

12,078-9 of 1917 (128,649-50). J. P. ROE, London. Guard sheaves for preventing ropes of aerial ropeways rising from the supporting sheaves.

15,629 of 1917 (128,676). SOCIETE DE METALLURGIE ELECTROLYTIQUE, Paris. Improved structure of rotary cathodes used in the electro-deposition of copper, zinc, and other metals.

467 of 1918 (128,327). P. L. HULIN, Grenoble, France. Removing water from hydrated magnesium chloride by means of hydrochloric acid formed in situ by burning hydrogen in chlorine gas.

6,097 of 1918 (127,930). COOPER CO., Cleveland, Ohio. An alloy used in making high speed tools, consisting of nickel or cobalt, zirconium, aluminium, or silica, with or without tungsten, molybdenum, chromium or uranium.

6,126 of 1918 (127,931). A. FRANCOIS, Doncaster. Method of pumping cement into cavities against pressure.

6,270 of 1918 (120,194). NEW JERSEY ZINC CO., New York. Making a pigment consisting of lead sulphate and zinc oxide by volatilizing the oxides from oxidized lead-zinc ores and submitting the oxides to SO_3 which converts the lead oxide to sulphate but has no effect on the zinc oxide.

9,379 of 1918 (127,964). P. J. MACDONALD and C. L. CLAFLIN, Los Angeles, California. Furnace for reducing oxides to metals by reaction with carbonic oxide or other gas.

9,622 of 1918 (127,985). Sir H. ROGERS and C. M. WALTER, Birmingham. Improved cathode construction for use in connection with the electrolytic recovery of tin from scrap.

10,509 of 1918 (128,729). BARCLAY & CO., LTD., Kilmarnock. Improved compressed-air engines for haulage between working faces and the main haulage-way.

11,378 of 1918 (118,605). NORTON CO., Worcester, Massachusetts. Improvements in the method of refining bauxite by excess of carbon in the electric furnace.

11,380 of 1918 (121,721). NORTON CO., Worcester, Massachusetts. Aluminous abrasives containing silica and an alkali oxide, the relative proportions of these being regulated according to the required strength of grain of the abrasive.

11,424 of 1918 (128,041). E. A. DAVIES and A. CRYER, Cardiff. In hoisting plant for mines using balanced cages, gear for adjusting the cages as the rope stretches.

13,245 of 1918 (128,455). G. H. T. RAYNER and P. RAYNER, Sheffield. Improved tool-retaining device for percussive rock-drills.

16,333 of 1918 (128,818). E. F. MORRIS, Roby, Liverpool. Method of obtaining white antimonious oxide from metallic antimony.

16,334 of 1918 (128,482). E. F. MORRIS, Roby, Liverpool. Method of manufacturing antimony pigments.

18,818 of 1918 (128,833). A. W. GREGORY, London. Removing tin from scrap by ammonium polysulphides.

381 of 1919 (128,507). AIR REDUCTION CO., New York. Extraction of cyanides from furnace products.

2,103 of 1919 (128,517). A. MAES, Souvret, Belgium. A machine for trimming mine timbers.

2,936 of 1919 (128,521). T. PRICE, Nanaimo, British Columbia. For the prevention of accidents due to breakage of wire ropes in hoisting plant where cages are balanced against each other, the provision of a second rope which winds on and off the same drums, in this way making it unnecessary to use bigger drums.

3,242 of 1919 (128,865). CERETTI & TEOFANI, Milan. Improved turning stations for three-cable aerial ropeways.

NEW BOOKS

☞ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

Practical Instructions in the Search for, and the Determination of, the Useful Minerals, including the Rare Ores. Second Edition. By Alexander McLeod. Price 6s 6d. net. New York: John Wiley & Sons.

This small but comprehensive work of reference is dated 1917, although it was received for review only a month ago. It is a type of book, unfortunately too common in America, which reduces the conscientious reviewer to despair, and makes him wonder why publishers accept certain technical manuscripts without subjecting them to a careful examination such as novels must undergo before they reach the greater permanence of print. The book itself is, in this case, one which would probably be useful to the prospector in the field; but the modern prospector, being a trained economic geologist or mining geologist, will recognize at once how much better it might have been done had a little more time been devoted to the technique of blowpipe analysis, and accuracy of nomenclature, and in the proof-reading stage to the deletion of infelicitous phrases and unnecessary opinions. As an example of the latter, we are told repeatedly that "absolutely no skill is required" to carry out the tests described, many of which are said to be "gorgeously simple." Frankly such a statement is not a compliment to the prospector, whether he be the rough diamond of the older mining fields, or the highly-trained specialist of to-day. The determination and location of minerals generally requires very rare skill, and an author who denies it adopts an unbecomingly modest attitude. As an example of inaccuracy of nomenclature (and fact) the following sentence is worthy of quotation (p. 9): "Some minerals, like tin, monazite, uranium, and wolfram, are only found in old strata."

The author, however, is filled with enthusiasm for his subject, and on p. 104 he momentarily drops into a poetic vein:

"Who says the prospector's day hath fled? His day is new; and it is merely early morn.

"And the continents, practically unexplored, especially as far as the rare ores are concerned, invite him to their undiscovered bonanzas."

ARTHUR HOLMES.

The Elements of Astronomy for Surveyors. By R. W. Chapman. Cloth, octavo, 247 pages, illustrated. Price 5s. net. London: Charles Griffin & Co., Ltd.

An Australian professor (University of Adelaide) has put this work together with the object of providing a succinct and reliable exposition, not only of the most serviceable methods of observation and computation, but also of the main principles on which they are based, and which should be thoroughly understood if the formulæ for the reduction of the field work are to be intelligently applied. He has endeavoured in his treatment of the subject to maintain a position intermediate between that of the severely practical text-book of surveying, which usually contents itself with cataloguing the results of trigonometrical inquiry, and that of the treatise on astronomy, which indulges in mathematical disquisitions too recondite for the beginner to follow, besides discussing many matters that have but a remote bearing on survey work. By thus keeping in view the needs of the student as well as of the practitioner, he has succeeded in producing a really useful book, and one that satisfactorily fills a gap in the literature of surveying.

The twelve chapters into which the volume is divided deal respectively with the following sections of the subject: The solution of spherical triangles; the celestial sphere and astronomical co-ordinates; the earth; the sun; the location of objects on the celestial sphere; astronomical and instrumental corrections to observations of altitude and azimuth; the determination of true meridian; the determination of latitude; the determination of time by observation; the determination of longitude; and the convergence of meridians. Many explanatory diagrams, fully worked out actual observations, and examples for working, are given; and considerable attention is paid to analysing the effects of various observational and instrumental errors.

Of all the operations performed by a surveyor in the field none is more fundamentally important than the establishment of a true meridian. To the ways of determining this the author has quite rightly devoted the longest chapter in the book. Four methods are discussed: Equal altitudes of a circumpolar star; circumpolar star at elongation; extra-meridian observations on sun or star; and time observations upon a close circumpolar star. The first may be ruled out by reason of its enjoining on the surveyor an almost all-night vigil; the second is on the whole the most satisfactory; the third is very convenient, and, especially when a star is used, is quite accurate enough for most purposes; the fourth, which is a variant of the second, is more suited to the precise requirements of the geodesist. By a little careful planning it is a fairly simple matter to arrange a programme of comfortable duration which includes observations on two circumpolar stars and on several east and west stars close to the plane of the prime vertical. The observations on the east and west stars can be fitted in before and between the observations on the circumpolars. If bright stars are available, operations may be begun half an hour or an hour before sunset, provided of course that the position of the stars on which daylight observations are to be made have been calculated beforehand. It is not generally known that Polaris can be observed with the ordinary engineer's transit a little before sundown or in the early dawn; and that it is possible to observe a very bright star like Sirius at almost any time of the day. It is better for beginners, however, to confine their star work to the dark hours; the constellations are then all visible; and with the aid of a chart the star observed can be identified with certainty, and can be easily brought into the field of view by sighting along the top of the telescope. The author employs for the reduction of extra-meridian observations the usual formula in which the co-angles are used; he does not mention the one which enables the computation to be entered with the direct angles. The formula which allows of this being done, a simple modification of one of the primary equations of spherical trigonometry, was derived by John G. McElroy, of Beckenbridge, Colorado, and is explained in the Michigan Engineer's Annual for 1889; it is much used in the United States. For the determination of latitude the method, among others, of meridian altitude of sun or star is given as the most convenient, and for precise work the method of zenith pair of stars. This latter method, devised by Captain A. Talcott in 1834, consists in observing two stars which culminate at approximately equal altitudes on opposite sides of the observer's zenith. Local mean time is generally obtained by means of an extra-meridian observation of the sun or of east or west stars, on similar lines to the extra-meridian observation for azimuth. In determining longitude the surveyor is usually restricted by circumstances to the method of moon-culminating stars, which, as the author points out, will, at best, permit him only an accuracy of 5 seconds of time, corresponding to $1\frac{1}{4}$ minutes of arc or to a distance of one mile near the equator. It is to be hoped therefore that astronomers will be able to address themselves to the longitude problem with some anticipation of relieving existing observational disabilities.

Surveyors would be further indebted to the author if he would indicate to them the degree of precision attainable by the various methods of observation when performed with the ordinary type of 6 in. transit theodolite. Standards for comparison are highly desirable in order that surveyors may be in a position to assess the quality of their work. They have probably read that with such an instrument azimuth should be obtained from the sun within from 1 to 3 minutes of the truth, depending on the care exercised, and from a circumpolar star within 20 seconds; latitude, by a pair of observations on a close circumpolar star, within 20 seconds, and by the Talcott method, within 10 seconds; and so on. A critical review of this question of reliability of result under prescribed instrumental conditions would be of considerable value.

ALEX. RICHARDSON.

Text-Book of Rand Metallurgical Practice, Vol. II. Second Edition. Cloth, octavo, 470 pages, illustrated. Price 25s. net. London: Charles Griffin & Co. Ltd.

Eight years or so ago a number of mining men and metallurgists on the Rand combined to publish a record of the methods adopted on that goldfield for crushing the ore and extracting the gold. A second edition of the first volume appeared a year or so after the first edition. A second edition of the second volume has recently made its appearance. In the interval a large number of variations in practice have been introduced, and the author, Mr. C. O. Schmitt, has revised and extended the volume accordingly. We would here say that the two volumes partly cover the same ground, but the first deals with the metallurgical problems of milling and extraction, while the second is concerned with the mechanical side or the design and construction of the plants. In looking through the new volume, we see that the sections devoted to stamp-mills and tube-mills have been modified, according to present practice in coarse crushing with heavy stamps and putting more of the work on tube-mills, and the theory of the design of tube-mills is at the same time expanded. Particulars are given of the Johnson & Winterton screen used for removing the finer material from the ore before being fed to the stamps, and the benefits of classification before tube-milling are discussed in greater detail. In the amalgamation section attention is drawn to the modern practice of placing the amalgamating plates below the tube-mills instead of below the stamps. In the chapters on the transport of materials, additional matter deals with the hardening of the surface of dumps and the carriage of sand for filling. The bibliography has been extended. Twenty new illustrations are given. The additional matter is not, altogether, very great, and some readers would doubtless have been glad if the modifications in practice had been described in more detail, especially seeing that descriptions already published are not now easy of access. During the past five years there has been little opportunity for extensive research, but Rand practice has not stood still and innovations in, for instance, precipitation and in dissolution and decantation will be introduced in practice as financial conditions allow. Necessarily, no note is made in this volume of prospective improvements.

Compressed Air Plant. Third Edition. By Robert Peele. Cloth, octavo, 490 pages, illustrated. Price 20s. net. New York: John Wiley & Sons; London: Chapman & Hall.

This is the third edition of a book that has had considerable vogue in the United States during the last ten years. Mr. Peele, as professor of mining in the Columbia School of Mines, has a large audience, and his recent "Mining Engineer's Handbook" has extended his influence throughout the world. Compressed air practice develops rapidly and much re-writing is necessary in preparing new editions. This book is useful as an exposition of American practice, and in this country it will be taken as a supplement to other text-books or courses of instruction. The main headings of the book are: the compression of air, the transmission of compressed air, compressed-air engines and other devices used in hoisting, haulage, and pumping, and rock-drills and similar percussive tools.

Studies in the Construction of Dams. By Professor E. R. Matthews. Paper boards, octavo, 48 pages, illustrated. Price 4s. 6d. net. London: Charles Griffin & Co., Ltd.

This book is written on the question and answer system, and is intended for students preparing for such examinations as that for the Associate Membership of the Institution of Civil Engineers. It covers earthen and masonry dams, and deals with calculations of design and general description rather than of the method of construction.

Oil and Petroleum Manual for 1919. By Walter R. Skinner. Cloth, octavo, 250 pages. Price 6s. net. London: Walter R. Skinner. This is the tenth annual volume of a well-known manual, giving particulars of all the oil-producing companies known in London.

The Inflammability of Aluminium Dust. By Alan Leighton. Technical Paper No. 152 of the United States Bureau of Mines.

Black-Sand Deposits of Oregon and Northern California. By R. R. Hornor. Technical Paper 196 of the United States Bureau of Mines.

Extinguishing and Preventing Oil and Gas Fires. By C. P. Bowie. Bulletin 170 of the United States Bureau of Mines.

Innovations in the Metallurgy of Lead. By D. A. Lyon and O. C. Ralston. Bulletin 157 of the United States Bureau of Mines.

Mining and Milling of Lead and Zinc Ores in the Missouri-Kansas-Oklahoma Zinc District. By C. A. Wright. Bulletin 154 of the United States Bureau of Mines.

Shutting-Off Water in Oil and Gas Wells. By F. B. Tough. Bulletin 163 of the United States Bureau of Mines.

Sulphur Dioxide Method for Determining Copper Minerals in Partly Oxidized Ores. By C. E. Van Barneveld and E. S. Leaver. Technical Paper No. 198, published by the United States Bureau of Mines.

Fifteenth Biennial Report of the Bureau of Mines of Colorado. This covers the years 1917 and 1918, and is issued by F. Carroll, Commissioner.

Third Annual Report of the State Oil and Gas Supervisor of California. By R. P. McLaughlin.

Canadian Mining Manual 1918. Edited by Reginald E. Hore. Published by *The Canadian Mining Journal*.

Limestone Deposits of New South Wales. By J. E. Carne and L. J. Jones. Sydney: The Geological Survey.

COMPANY REPORTS

Broken Hill Block 10.—The report of this company for the half-year ended March 31 shows that 27,762 tons of ore was raised, averaging 11·03% lead, 10·8% zinc, and 9·65 oz. silver per ton. This ore, together with 13,447 tons of Block 14 ore, averaging 14·29% lead, 11·63% zinc, and 10·92 oz. silver per ton, was sent to the joint concentration plant. The total of ore treated was 41,209 tons, averaging 12·09% lead, 11·07% zinc, and 10·06 oz. silver per ton. At the water-concentration plant the yield was 5,886 tons of lead concentrate averaging 64·17% lead, 6·62% zinc, and 34·98 oz. silver. Of the tailing products 11,064 tons of lead slime, averaging 6·3% lead, 13·16% zinc, and 9·36 oz. silver was sent to the lead-flotation plant, where 823 tons of lead concentrate was extracted averaging 57·03% lead, 11·18% zinc, and 76·24 oz. silver. The tailing from the two lead plants, amounting to 34,500 tons, averaging 11% zinc, 2·14% lead, and 4·23 oz. silver, was sent to the zinc flotation plant, where 7,199 tons of concentrate was produced, averaging 46·8% zinc, 5·36% lead, and 12·72 oz. silver. The final residue, amounting to 27,301 tons, averaged 1·29% lead, [illegible] zinc, and 2 oz. silver. The profit for the half-year was £16,859, out of which £15,000 was distributed as dividend, being at the rate of 3s. per £10 share.

Broken Hill Block 14.—The mining of sulphide ore was resumed in November, 1917, after the company had depended for its income for many years on carbonates from the old stopes in the upper levels. At first the sulphide was sent to the Junction North mill, but from June, 1918, it has been sent to the new treatment plant owned jointly by this company and Block 10. The report for the half-year ended March 31 last shows that 13,447 tons of sulphide ore was raised and treated. Particulars of treatment are given in the preceding paragraph. During the same period, 3,817 tons of carbonate ore, averaging 22·32% lead and 13·62 oz. silver per ton, was raised. The accounts show a profit of £7,748, of which £1,975 was received as dividend on shares held in the King Island Scheelite Co. The dividends absorbed £6,500, of which £1,500 went to the preference shares, and £5,000 to the ordinary shares of £1. 5s. each.

Briseis Tin & General Mining.—This company was formed in London in 1899 to acquire alluvial tin deposits in the north-east of Tasmania. On the exhaustion of the original properties, others adjoining were purchased, and subsequently alluvial gold mines were acquired in Victoria. Lake & Currie are the consulting engineers, and Lindesay C. Clark is general manager. The report for 1918 shows that at Krushka's Flat 197,000 cu. yd. yielded 256·8 tons of tin concentrate; at Ringarooma 300,000 cu. yd. yielded 65 tons, and at Mutual Hill 38,953 cu. yd. gave 7·6 tons. The total yield was 328 tons, which, on treatment at Launceston, yielded 234·3 tons of metallic tin. The tin was sold in Australia for £74,888, the average price being £319. 12s. 6d. per ton. Owing to low rainfall and consequent shortage of water, development of the properties by removal of overburden and re-diversion of the river have been retarded, and a smaller output may be expected this year. Owing to the greater depth of the workings it will be necessary to look out for additional water-supply. The Mutual Hill workings have been exhausted. In Victoria the last dredge in operation treated 238,600 cu. yd. for a yield of gold worth £3,899. Operations at these properties have now ceased. An option has been obtained on an alluvial property at Gulgong, New South Wales, and boring is being conducted. The company's accounts show a net profit of £39,270, out of which £30,000 has been distributed as dividend, being at the rate of 5%.

Lake View & Star.—This company was formed in 1910 to acquire the gold-mining properties of the Lake View Consols and Hannan's Star companies at Kalgoorlie, West Australia. Bewick, Moreing & Co. are the general managers, and James Brothers are the consulting engineers. The report for the year ended February 28 last shows that 114,613 tons of ore was treated, for a yield of gold worth £136,507. The balance of profit was £4,967, out of which and the balance brought forward from the previous year £5,000 was written off for depreciation of plant. The amount of ore treated was 25,073 tons less than in the previous year, this reduction being in pursuance of the policy of selective mining during the period of high costs and scarcity of labour. Developments at the Lake View mine continued to disclose both oxidized and telluride ore. In Hannan's Star, ore was found in a winze below the 1,100 ft. level. At Chaffers, No. 2 lode was opened up further on the 2nd and 3rd levels. In spite of the development at the three properties being restricted, the ore reserves were maintained. They now stand at: Lake View 55,401 tons averaging 28s. 8d., Hannan's Star 240,213 tons averaging 25s. 10d., Chaffers 4,660 tons averaging 26s. 7d. per ton.

Bullfinch Proprietary.—This company was formed in 1910 by Sir George Doolette, D. L. Doolette, and others to acquire a gold-mining property near Southern Cross, West Australia. The mine has not developed in depth in the way that was hoped, judging from the rich ore near surfaces, and dividends have been small. The report for 1918 shows that 57,609 tons of ore was treated for a yield worth £60,412, equal to 20s. 11d. per ton, while the mining cost was £58,582. The ore reserve is estimated at 59,498 tons of similar tenor to that milled during the year, and developments continue to disclose the same quality of ore. If the working costs can be restored to their former level, or if ore of higher grade is discovered, a return to dividend-paying may be expected. In order to place the company on a sounder financial basis and provide funds either for extra development or for the purchase of a new property, reconstruction is to be undertaken. Present £1 shares are to be exchanged for a similar number of 5s. shares, and 200,000 new 5s. shares are to be created and issued for cash whenever the occasion arises.

Consolidated Gold Fields of New Zealand.—This company was formed in 1896 to acquire from David Ziman a number of gold-mining properties at Reefton, New Zealand. The Progress and Blackwater mines were floated as subsidiaries, and the company continued to work the Wealth of Nations. The report for 1918 shows that in April of that year a fire caused the cessation of work, and the mine is only now being reopened. During the short time the mine was working, gold worth £4,955 was recovered. The company also received dividends of £4,606 from its holding in Blackwater Mines. The profit was £2,221.—**Progress Mines.** During 1918, the mill treated 16,320 tons of ore for a yield of £23,375, at a working cost of £21,893. There was also charged against revenue: development £4,280, depreciation £2,978, and debenture interest £1,719, so that there was a debit balance of £5,776. **Blackwater Mines.** During 1918, the mill treated 31,728 tons of ore for a yield of £61,309, while the working cost was £38,597. After allowing for development and depreciation, the net profit was £10,885. Dividends absorbed £12,499, being at the rate of 5%. The ore reserve is estimated at 84,887 tons averaging 10·84 dwt. per ton over 3 ft. The mining operations of this group have been greatly hampered by scarcity of labour.

Siamese Tin.—This company was formed in 1906 to dredge alluvial tin ground at Ngow, in the Renong district of the Western Siamese States. H. G. Scott is general manager, and A. N. Wakefield is manager at Ngow. The report for the year 1918 shows that two of the three bucket-dredges were out of commission for a considerable time owing to the necessity for repairs. The total ground treated was 1,656,900 cu. yd., and the output of tin concentrate was 777 tons. The yield per yard was 1·05 lb., worth 17·48d. The income was £212,707, and the net profit £35,652, out of which £30,000 has been distributed as dividend, being at the rate of 25%.

Ipoh Tin Dredging.—This company was formed in 1913 to acquire alluvial tin property in the Kinta valley, Perak, Federated Malay States. Since 1915 the local management has been in the hands of the Borneo Company. Reginald Pawle is chairman, and L. G. Attenborough is mine manager. The report for 1918 shows that 634,820 cu. yd. was treated, for a yield of 246½ tons of tin concentrate. The yield per yard was 0·82 lb. The proceeds of the sales, less Government taxes, were £45,219, and the net profit was £14,916, out of which £8,960 has been paid as dividend, being at the rate of 10% free of tax. The amount of ground dredged during the year was 9½ acres, and the average depth was 41½ ft. The dredge was in rather poor ground part of the time. A new screen and new buckets have been supplied recently. During the year a block of land with an area of 10½ acres was acquired. This area is not valuable for tin contents, but affords room in which the dredge can turn.

Kramat Pulai.—This company belongs to the Tronoh group, and was formed in 1907 to acquire alluvial tin property at Pulai, in the Kinta valley, Perak, Federated Malay States. Dividends have been paid since 1912. B. W. Thunder is manager. The report for 1918 shows that 177 tons of tin concentrate and 70 tons of scheelite concentrate were extracted. In addition, 114 tons of tin concentrate and 71 tons of scheelite concentrate were won by tributers. The income from the sale of the company's output was £41,037, and the income from tributing was £7,603. The net profit was £35,551, out of which £25,000 has been distributed as dividend, being at the rate of 25%. Part of the balance will go as Excess Profits Duty.

Burma Ruby Mines.—This company was formed in 1889 by the Rothschilds to consolidate a number of alluvial properties containing rubies and other precious stones at Mogok, Burma. The financial results have been generally disappointing. The report for the year ended February 28 last shows that 903,760 loads of ground was washed for a yield of stones valued at £44,168. The trading account shows sales of stones locally £46,145, and in London £4,697. The year's work ended in a loss of £562, which, added to the deficiency of £6,753 brought forward from the previous year, make a total debit of £7,316. The company has suffered from lack of labour, due to natives preferring to work on tribute and to their going to other mines, such as those of the Burma Corporation. Another adverse circumstance is the exhaustion of the better grade ground in the neighbourhood of the treatment plant. New methods of treatment are being tried experimentally.

Libiola Copper.—This company was formed in 1867 to reopen a pyrites mine near Sestri Levanti, in north Italy, not far east of Genoa. The report for 1918 shows that owing to war conditions, the output of pyrites continued to decrease. The mining costs were 60% higher than in 1917. The profit for the year was £1,819. The reserve is estimated at 990 tons of copper ore and 11,000 tons of pyrites. Since the armistice, the demand for pyrites has fallen away, and this, together with labour troubles, made it necessary to close the mine. It is impossible to say when work can be profitably resumed.

Esperanza Copper & Sulphur.—This company was formed in 1906, to acquire the Esperanza, Forzosa, and Angostura pyrites mines in the south of Spain. G. Mure Ritchie is chairman, and T. D. Lawther is managing director. The report for 1918 shows that 62,720 tons of pyrites was raised, being 23,913 tons less than 1917, and that the shipments from the port of Huelva were 67,546 tons, or 11,732 tons less than in the previous year. The output of copper precipitate was 60 tons, as compared with 104 tons. The net profit for the year was £4,761, to which was added £17,897 brought forward, making a disposable balance of £22,658. Out of this, £17,500 was distributed as dividend in August last, being at the rate of 5%. The shipments throughout the year were irregular, owing to war conditions. After the signing of the armistice, demand ceased temporarily. It became necessary to suspend operations at Angostura and Forzosa at the end of October, and at Esperanza in January, 1919. The Esperanza was re-opened in June. The San Daniel and Nueva Esperanza properties have not given good results in development, and work has been stopped. The company's total ore reserves are estimated at 886,000 tons. The company has recently acquired control of the New Lymni Company, which owns extensive low-grade pyrites deposits in Cyprus. The company has also purchased a small copper-extraction works at Stockton-on-Tees.

Poderosa.—This company was formed in 1908 to acquire from local owners a group of copper mines at Collahuasi, Chile, not far from the Antofagasta & Bolivia railway. The report for 1918 shows that shipments of ore to the United States were suspended in June, owing to shipping restrictions, and accumulated ores had to be disposed of locally. Mining operations thereafter ceased for a time. The concentration plant was shut down in May owing to bad weather and shortage of fuel. Under the financial strain caused by reduced outlet for products, it was impossible to do much development. The output of ore at the Poderosa was 2,557 tons averaging 32% copper, and at the Rosario 242 tons averaging 27%. At the concentration plant, 3,547 tons averaging 4·2% copper yielded 316 tons of concentrate averaging 26% copper. The total shipments during the year were 3,309 tons averaging 30·7%. The ore also contains silver, the average of that shipped being 12·45 oz. per ton. The reserve is estimated at 8,000 tons averaging 22%, and 5,000 tons of milling ore averaging 5%. The accounts show receipts from the sale of products £60,100, and a debit balance for the year of £18,662.

Antelope.—This company was formed in 1908 by the Rhodesian Exploration & Development Co. to acquire gold-mining properties in the West Gwanda district of Rhodesia, 60 miles south of Bulawayo. Control passed subsequently to the Gold Fields Rhodesian Development Co. Milling commenced toward the end of 1913, the process consisting of dry crushing, roasting, pan-amalgamation, and cyaniding. No dividend has been paid. The report for 1918 shows that 39,830 tons of ore was treated, for a yield of 18,224 oz. of gold, selling for £79,565. The working cost was £78,176. Various factors have combined to make the situation unsatisfactory, such as the intrusion of a dyke, higher pumping and hoisting charges, and the labour position. The directors decided therefore to cut down all unproductive expenditure and draw on reserve stores in the hope of continuing work at a profit for some months.

Transvaal Gold Mining Estates.—This company was formed by the late Nicol Brown in 1882 to acquire gold-mining properties at Pilgrim's Rest, in the Lydenburg district of the Transvaal. In 1895 it was amalgamated with the Lydenburg Mining Estates, since when it has been in the control of the Central Mining group. The report for the year ended March 31 last shows that at the Central mines 112,130 tons of ore yielded gold worth £172,456, at the Elandsdrift mine 14,870 tons yielded £35,333, and at the Vaalhoek 16,650 tons yielded £22,419. The total ore treated was 144,245 tons and the yield £231,359. These figures compared with 182,685 tons and £336,438 the year before. The working cost was £196,546 as compared with £219,128, and the working profit £34,813 as compared with £117,310. The unfavourable results are attributed to the cessation of work caused by the influenza epidemic, the lower grade of the ore mined, and the increasing costs. The reserves are estimated at Central mines 408,873 tons averaging 8·25 dwt. per ton, Elandsdrift 70,700 tons averaging 15·2 dwt., and Vaalhoek 51,041 tons averaging 8·73 dwt. The shareholders received a dividend of £15,105, at the rate of 2½ per cent.

Jupiter.—This company belongs to the Consolidated Gold Fields group and works a deep-level gold mine on the Rand, below the Geldenhuis Deep and adjoining the Simmer Deep on the east. Owing to the low grade of the ore the mine was closed from 1913 to 1915. In the latter year the Howard section was reopened. The report for 1918 shows that 268,375 tons of ore was mined and 267,022 tons sent to the mill. The yield of gold by amalgamation was 44,801 oz. and by cyanide 30,803 oz., making a total of 75,604 oz., worth £315,810, equal to 23s. 8d. per ton milled. The working cost was £312,589, or 23s. 5d. per ton, leaving a working profit of £3,221, or 3d. per ton. A dividend of 1¼%

absorbing £12,677 was declared in December, out of a balance brought forward from 1917. The reserve in the Howard section is estimated at 674,000 tons averaging 5·98 dwt., as compared with 787,000 tons averaging 5·27 dwt. the year before. The variation in figures is caused by the elimination of blocks of low-grade ground. Sinking of the Howard incline was suspended at the 11th level owing to the dangerous nature of the hanging wall, and an auxiliary shaft is to be sunk to the south east.

Simmer Deep.—This company belongs to the Consolidated Gold Fields group, and was formed in 1906 to amalgamate several companies owning deep levels below the Simmer & Jack and Rose Deep in the eastern part of the Central Rand. Milling commenced in 1908, with a plant owned conjointly with the Jupiter. No dividend has ever been paid. The share capital is £1,650,000 and there are £689,400 debentures outstanding. The report for 1918 shows that 522,203 tons was raised, and 516,700 tons sent to the mill. The yield of gold by amalgamation was 72,353 oz., and by cyaniding 51,748 oz., making a total of 124,101 oz worth £518,924, being an extraction of 20s. 1d. per ton milled. The working cost was £546,796, or 21s. 2d. per ton, involving a loss of £27,871 or 1s. 1d. per ton. The loss is largely due to temporary causes such as the influenza epidemic and scarcity of labour, and as the development is now giving improved results, a turn for the better is expected. In the meantime power to issue prior lien stock was obtained and the Consolidated Gold Fields underwrote £100,000 of the issue. The ore reserve is estimated at 932,000 tons averaging 5·02 dwt. per ton

Ginsberg.—This company belongs to the Barnato group, and was formed in 1892 to acquire an outcrop property in the middle east Rand. The Balmoral property was absorbed in 1906. The report for 1918 shows that, after sorting, 155,330 tons averaging 4·95 dwt. per ton was sent to the mill. The yield by amalgamation was 20,507 oz., and by cyaniding 14,776 oz., making a total of 35,283 oz., worth £150,308. In addition, £2,062 was recovered from 4,366 tons of accumulated slime. The net profit for the year was £4,595, which was carried forward. The ore reserves have been steadily depleted, and stood on December 31 at 59,194 tons. It is expected that the mine will be exhausted before the end of the year.

Glencairn.—This company belongs to the Barnato group, and was formed in 1889 to acquire property on the outcrop in the middle east Rand. As already recorded, the mine is exhausted and hoisting ceased last November. The report for 1918 shows that 218,786 tons of ore was raised, and after the rejection of 8% waste, 200,900 tons averaging 3·5 dwt. was sent to the mill. The yield by amalgamation was 20,443 oz., and by cyaniding 10,519 oz., making a total of 30,962 oz., worth £132,152. In addition, £5,029 was obtained from 16,868 tons of accumulated slime, and £5,407 from clean-up of the mill. The net profit was £6,796, which, with the balance £20,838 brought forward from the previous year, made a disposable balance of £27,634. Out of this, £27,500 has been distributed as dividend, being at the rate of 5%. Operations are now confined to the treatment of accumulated slime, of which there remains about 190,000 tons averaging 2 dwt. The rate of treatment will be 7,500 tons per month.

New Primrose.—This company was formed in 1887 to acquire claims on the outcrop in the middle east Rand, and milling commenced in 1888. During the next few years several adjoining properties were absorbed. For many years satisfactory dividends were paid, but the end is now near. The control is with the Barnatos. The report for 1918 shows that 200,936 tons of ore was raised, which together with 10,914 tons from the dumps was sent direct to the mill. The yield of gold by amalgamation and cyanide was 43,661 oz., worth £186,223, being an extraction of 17s. 7d. per ton. The working cost was £172,711, or 16s. 4d. per ton, leaving a working profit of £13,512 or 1s. 3d. per ton. The reserves dwindled rapidly during the year, and at December 31 stood at 65,690 tons averaging 6·1 dwt. There is in addition a large amount of ore that in parts may be worth working.

Robinson Deep.—This company belongs to the Consolidated Gold Fields group, and was formed in 1898 to acquire property below the Ferreira Deep and Robinson Deep, in the central part of the Rand. In 1915 the company was reorganized on the acquirement of the Booysens property on the dip, and in 1918 the assets of Turffontein Estate were bought for shares. A new deep level shaft, known as the "Chris," has been sunk to tap the property on the dip. The South Reef was reached in June last year at a depth of 3,990 ft., and the working of the Chris section was started in September. The report for the year 1918 shows that 52[illegible],300 tons of ore was raised and sent to the mill. The yield by amalgamation was 109,692 oz. of gold, and by cyaniding 61,317 oz., making a total of 171,009 oz., worth £714,034, or 26s. 11d. per ton. The working cost was £679,808, or 25s. 8d. per ton, leaving a working profit of £34,225, or 1s. 3d. per ton. Other items brought an income of £5,230, and £36,334 was disbursed as interest on loans, special war expenditure, income tax, levies under Miners' Phthisis Act, etc. The amount spent on equipment and shaft-sinking during the year was £125,005. Owing to interruptions in hoisting, the tonnage milled was 32,100 tons less than during the previous year. The yield per ton was 6d. less, the working cost 3s. 3d. higher, and the working profit £108,466 lower. The abnormal rainfall at the end of 1917 and early in 1918 flooded the mine and caused delay in development and connection to the Chris shaft, and in the installation of the mechanical haulage system on the 35th level. The No. 2 shaft went out of commission at the end of 1916, and until the Chris shaft was completed, the whole of the hoisting had to be done through No. 1 shaft. Since the end of 1918, No. 1 shaft has been closed for repairs, and hoisting has been done through the Chris shaft. When the repairs are completed, a period of prosperity may be expected to return. The ore reserve at December 31 was estimated at 1,632,000 tons averaging 6·9 dwt. per ton. In addition 85,000 tons of partly developed ore have an indicated content of 6·42 dwt. At the end of 1917 it was necessary, on account of rising costs, to eliminate 175,000 tons of low-grade ore from the estimate. At the end of 1918, owing to still further rises, 176,000 tons were classified as unpayable. On December 31, 1917, the reserve was estimated at 1,725,000 tons averaging 6·43 dwt. About half of the reserve is available for working through the Chris shaft. When the cross-cuts from the Chris reach the reef the rate of development will be considerably accelerated.

Glencoe (Natal) Collieries. — This company was formed in Natal in 1901 to acquire coal properties in the Dundee district, Natal. The report for 1918 shows that work was greatly hindered by floods, and that additional pumps to cope with the situation were unobtainable. Scarcity of labour, following the influenza epidemic, also caused a decrease in the output. The output of coal was 86,322 tons, as compared with 140,955 in 1917. The accounts show a loss of £3,678. A dividend of £6,250 was distributed out of the previous year's balance, being at the rate of 2½%.

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.SC., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill*, both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION { U.K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XXI. No. 3. LONDON, SEPTEMBER, 1919. PRICE ONE SHILLING

CONTENTS.

EDITORIAL

CABLE restrictions have been considerably relaxed during the last month or two, and mining engineers are once more permitted to use McNeill's Codes. The Defence of the Realm Act regulation preventing the use of this code was quite unnecessary and unjustified. It imposed an inconvenience on the mining profession, and the temporary stoppage of the sale of the code involved a great hardship on our good friend the late Bedford McNeill. For the sake of those he has left behind him, we hope the sale of the codes will rapidly resume its old proportions.

GERMAN brutality of method is not yet dead, as the Polish population of the coal and zinc regions of Upper Silesia can testify. The district was one of Germany's treasure-houses and its permanent loss to the enemy, for so he must still be called, would be a severe blow to him. The Allied Council, in a fit of weakness or generosity, agreed to refer the question of the political control to a plebiscite, and the Germans promptly resorted to means for making the referendum a farce. Terrorizing the population so as to deter it from voting, or even to drive it out of the country or cause it to rebel, has been the weapon employed in rendering the Treaty futile.

IN another part of this issue particulars are given of the condition of the non-ferrous metallurgical industries of Belgium. These industries have been the victims of German hatred, but they owe their present parlous position largely to the economic unsettlement of things generally throughout the world. The smelters of zinc, lead, silver, and copper ores depended for their living on imported ores and on cheap local coal and labour. With only limited supplies of ore at reasonable prices, and with coal and labour increased incredibly in cost, there is little encouragement toward reconstruction, and the reopening of metallurgical plant is restricted and tentative.

ON another page we reproduce part of the discussion on Mr. W. H. Goodchild's paper on the evolution of ore deposits from igneous magmas, read at the June meeting of the Institution of Mining and Metallurgy, together with the author's replies. Space prevents any extensive quotation, so only those parts which dealt directly with the argument can be given. Readers who desire to follow the discussion in full will find it in the bulletins of the Institution. The discussion suffered from the fact that the paper presented to the Institution was brief and did not contain the elaboration of detail that characterized the original articles in this Magazine. Consequently some of the speakers, who had not read these articles, did not grasp the full significance of the theory. As their criticisms and suggestions are answered in the articles, the discussion arising need not be reproduced in our pages.

BEFORE Parliament adjourned for the autumn recess, Mr. Lloyd George gave a preliminary statement relating to the Government's coal-mining policy. He threw over Mr. Justice Sankey's recommendation for nationalization of the coal mines, and foreshadowed a scheme on the lines of Sir Arthur Duckham's suggestion contained in his minority report. The miners, under the leadership of Mr. Robert Smillie, reject this Government proposal in advance. We have not space for a discussion of the Duckham plan, but, briefly, it lays the responsibility for the future good management of the country's coal resources equally with the Government, the coal owners, and the miners. The machinery of management under the plan would be such that no one party to the agreement could take a defiant attitude without losing the confidence of the manufacturing industries and of the people at large. The rank and file of the workers would do well to take the proposal seriously, and to cut away from the irreconcilable element among the agitators.

GOOD news is to hand with regard to the Camborne School of Metalliferous Mining. Mr. J. G. Lawn has consented to take the position of Acting-Principal for a time, and to conduct the mining classes, until the governors find an engineer who can accept a permanent appointment. It will be remembered that he was lecturer at the school during the years 1907 and 1908. It is also announced that Mr. H. W. Hutchin has been appointed lecturer on assaying, taking the position formerly occupied by the late Mr. J. J. Beringer. Mr. Hutchin was for some years lecturer at the school, but left in 1908 to establish a private practice. Under the new arrangement, he will continue some portion of his private practice, particularly his work for South Crofty. The school has been further strengthened by additional appointments on the mechanical, electrical, and mathematical sides. Alluvial mining is to be added to the curriculum, and ground suitable for this class of instruction has been secured at the head of the Red River valley near Bolenowe, about two miles south-east of Camborne. Mr. T. Knowles, who has manfully kept the flag flying during the anxious times of the last few years, now takes the post of vice-principal and secretary, and will conduct the chemical classes. The school is full for the coming session. It is a matter of sincere congratulation to all concerned, including the mining profession, that Camborne Mining School has entered another era of success and usefulness.

TWO men of outstanding personality passed away during the month of August: Andrew Carnegie and Louis Botha. The first-named was known conventionally as the steel king and the philanthropist, and we will let it pass at that. Louis Botha was a man of far greater influence for good. He was rapid in action and decision when circumstances demanded, yet easy and urbane when it was of advantage to give those who disagreed with him a chance of meditation and re-examination of the matter under controversy, and for that reason he was the ideal head of a new community that had passed through turmoil and trouble. A brave foe, a steadfast friend, whose word was his bond, and having a high sense of public duty, he was a figure that might have stepped out of the pages of Sir Thomas Malory or Sir Walter Scott. When political difficulties arise in the future, in South Africa or elsewhere within the Empire, the watchword might well be: " Remember Louis Botha."

Tehidy and Lanhydrock.

In these days, when the owners of mineral rights are denounced, by a certain section of the indiscriminating public, as the essence of wickedness, it is undoubtedly a judicious policy of the lords to sell these rights to commercial organizations or go partners with such companies. Other influences have also been at work among royalty owners of late years in bringing them to a decision to depart from old practice, and many shrewd observers among them have come to see that under modern conditions a change in methods of tenure and administration would bring benefits to the estates and to the employees, provided the purchasing company is not a mere incorporated landlord, but a group of men of business sagacity and sound mining knowledge. But, of course, there are landlords and landlords. It is permissible to quote this old tag in connection with Tehidy Minerals, Limited, because it is unusually applicable in this case. The company was formed half-a-year ago to acquire the mineral rights of the Tehidy estate, in the Camborne-Redruth district, belonging to the Basset family, other than those purchased by Dolcoath and East Pool. The present head of the Basset family may be taken as one type of landlord. Another deal has followed quickly, for it was announced last month that negotiations were completed for the acquisition of the mineral rights of Viscount Clifden, of Lanhydrock. In contrast with Mr. Basset, Lord Clifden has always taken a deep interest in his great possessions. The humorist in *Punch* may have had him in mind when he drew the picture of the farmer proposing the landlord's health at the annual rent dinner in these words: " If all squires would do as our squire do, there would not be so many squires do as they do do." And in this pleasant feeling of friendliness, all Cornwall includes his agent, Mr. John Gilbert. As far as the purchasing company is concerned, we may fitly describe it as a combination of the talents of Dolcoath and East Pool, and the names of Mr. Oliver Wethered and Mr. C. Algernon Moreing deserve special mention.

In the July issue we gave particulars of the rights acquired by Tehidy Minerals, and a map indicating the extent of the property. The Tehidy estate is all in the Camborne-Redruth district. On the other hand, Lord Clifden's interests are more widely distributed. At the time of writing, no map is available, but one will be published before long. From the point of view of present tin-mining operations, the most interesting portion of the property is the Tincroft and the Agar section of East Pool & Agar, with the adjoining North Pool, West Tolgus, and North Seton blocks. This group of properties fits like a jig-saw puzzle, as Mr. Wethered said in his speech, between the Tehidy properties, and their acquisition will be of great benefit to the proper development of the ground in that district. There are many tin mines worth re-opening in other parts of the Clifden estate, at Phillack, Gwinear, St. Just, St. Hilary, Gulval, Wendron, and Caradon respectively, and silver-lead mines that have been worked in the Bodmin Moor district. The estate also contains a number of hematite deposits, in the districts of Roche, Lanivet, and Withiel in central Cornwall.

The most interesting feature in connection with the deal is that Lord Clifden's estate includes many china-clay workings and extensive areas containing undeveloped deposits. The most important of these are to the west of St. Austell, and they include the Carpalla property, which figured in the famous legal query: "Is China-Clay a Mineral?" Other deposits are on Bodmin Moor, at Wendron, and Gulval. The china-clay will be an important source of strength to Tehidy Minerals, particularly on account of the fact that the Cornish producers control the trade of the world, and sellers and buyers are in direct touch. In this way the china-clay producers are at an advantage over the tin miners and tin users, who are at the mercy of middlemen.

It seems to us that the Tehidy Minerals company promises to be the most important factor in Cornish mining that has ever been known, and that its influence on mining, geological, and metallurgical problems will be of immense benefit to non-ferrous mining in this country. The fact that the ownership of the minerals is in the hands of the people actually working them gives a freedom of policy not hitherto experienced. It has always been and still is true that the development of ore deposits is hampered by the indifference of the majority of royalty-owners, a notable exception, of course, being the Clifden estate, and in many cases the complicated subdivisions of ownership have made it well nigh impossible to obtain compact leases of mining properties. This drawback has been emphasized recently by difficulties in the Pendeen and St. Agnes districts, but it is ever present with us. For this reason it is to be hoped that the policy of purchasing royalties will become the recognized practice. It may be asking too much of Tehidy Minerals to expect the board to go further and acquire other mineral royalties, such as those of the Tregothnan estate. Other mining houses may incline to follow the lead of Tehidy Minerals and adopt the same procedure in dealing with mining properties. We take this opportunity of warning them in advance that they will only succeed if they can show competent and conscientious methods of business and technological management.

Broken Hill.

Mining news has not been arriving in this country from Australia with any regularity during the last few years. The war and its consequences as regards cost and scarcity of materials and labour are largely the reason, but, in addition, the decline of old mining districts and the absence of important new finds have also contributed to the dulness of the news. In the midst of this period of comparative silence on the part of the journalists, several interesting ventures that have been started recently have not received the attention they deserve. One of these is the promised re-exploration of the country to the north and south of Broken Hill. In the June and the current issues we quote articles in Australian papers relating to this revival of interest, and giving brief statements of the geological theory put forward by Messrs. Alexander and Allen Marshall. The news as it comes to hand is not very intelligible to English readers, for it assumes too much local knowledge, especially of the past history of this part of New South Wales. We have therefore prepared an outline map of the district, and by its means the present problem will be more readily appreciated.

SKETCH MAP OF THE BROKEN HILL DISTRICT.

Considering its great commercial importance as a producer of silver, lead, and zinc, Broken Hill deserves a greater attention on the part of geologists than it has received. For twenty-five years Mr. J. B. Jaquet's classic has been the standard authority on the geology of the district. This report was prepared for the Geological Survey of New South Wales in 1893, just eight years after the Broken Hill Proprietary company was formed. From then until two years ago, neither the Geological Survey nor the mine-owners pursued the investigations on any comprehensive scale. In 1917, however, the companies jointly provided funds whereby an entirely new survey could be made, and the Geological Survey commissioned Mr. E. C. Andrews to undertake the work. If it had not been for the liberality of the companies, the Survey would not have been able to devote the close attention to the examination that the conditions warrant, but as the companies will receive the chief benefit, it is right that the funds should come from this source. Mr. Andrews does not expect to have completed his investigations before the end of the present year, so his report will not be available for some time yet.

Silver-lead ore was first discovered in this part of New South Wales at Thackaringa in the year 1880, and the deposits at Umberumberka and Pinnacles were worked a year or two after. In 1883 the giant outcrop of Broken Hill was tackled, but as it was covered with a compact iron cap the nature of the ore to be expected underneath was not understood. In those days the occurrence of tin and platinum also attracted attention. After the Broken Hill lode had been opened up, its geology and that of the district began to be studied. The rocks were determined as Silurian schists much folded, and the main ore-body was found to occupy the saddle of a fold. The strike of the rocks is approximately NE—SW and that of the ore-bodies follows it. There are other parallel lodes, the saddles of which have disappeared. The present Broken Hill workings extend for about three miles, but mining has been conducted in earlier years at points farther along the strike of the rocks, south-westerly at Pinnacles and north-easterly at Round Hill and Piesse's Knob. The ore and rocks at these outlying places are similar to those at Broken Hill, but the lodes do not contain bonanzas. The arguments advanced by the brothers Marshall relate to the possibility of finding bonanzas similar to that at Broken Hill in these extensions north-east and south-west. A study of the plans and models of the workings at Broken Hill lead to the belief that the saddle should be more correctly called a dome, and that there may be a succession of dome structures along the strike. The way in which the ore-bodies north and south pitch leads to a belief that they may pass through troughs and come near to the surface again. Plenty of money is forthcoming for the testing of these theories, some of it being provided by the Proprietary, Block 10, and Junction companies. Additional work at some of the old properties such as Round Hill and White Leads will add to the knowledge of the geological structure of the country. After this development has been carried out and when Mr. Andrews has issued his report, there will be more information available on which to determine a scientific line of attack. But it must always be remembered that in highly contorted and broken rocks the bonanza may be discovered by accident.

Pulverized Coal.

The mining engineer who takes non-ferrous metals as his particular study is confronted with a greater variety of power problems than usually confront his confrère in other branches of the profession. He may be called at short notice to conduct mining operations in any part of the world, and under every conceivable condition as to sources of power. In erecting a hoisting plant or a stamp-mill investigations must be made with a view of securing the cheapest and most dependable means of driving it. The steam engine will be used if coal is cheap enough and water is plentiful, or wood may be employed for steam-raising if the forests are handy. If water is scarce and irregular, coal, coke, or wood may be gasified and internal-combustion engines adopted. If oil can be obtained at reasonable rates, the engine of the Diesel type may offer advantages, or the oil-spray may be fixed in the steam boilers. A waterfall or a catchment basin naturally suggests an electric installation. The eventual choice of the source of power does not, however, depend solely on the ready delivery of coal, wood, oil, or water. There are other factors to be considered. One question to be raised relates to the best method of distributing the power to the various places where it is required, and in this connection it may be best to have separate engines direct-connected, or it may be advantageous to distribute electrically. Occasionally compressed air has been used for distributing power throughout the mine, and in any case it is the medium for operating rock-drills. Another factor arises from the association of a smelting plant with the mine. Fuel will then be required for heating purposes in the furnaces, and on the other hand the furnace gases may be employed for power production at the mine or smelter either in steam-boilers or in gas engines. A further factor is the recovery of the by-products, such as ammonia and the tar compounds, obtained when gasifying the coal or wood. Finally the engineer has to decide on the best method to adopt from the point of view of the life of the mine and its productivity. That is to say, the capital outlay required for the cheapest form of power may be greater than is warranted by the prospects of the mine, and the balance between current working cost and capital expenditure will have to be judiciously studied.

With the present advance in the price of fuel, the power and metallurgical problems become accentuated, and all possible methods for reducing the bill, whether at the power-house or the smelting furnace, must be closely investigated. For this reason we take the opportunity of drawing the attention of our readers to the use of pulverized coal. In this issue we print a paper sent to us by Mr. W. L. Wotherspoon, of the International Nickel Company, on the use of pulverized coal in copper blast-furnaces. This paper has already appeared in the July *Bulletin* of the Canadian Mining Institute, but the subject is of such great importance that republication on this side of the Atlantic is desirable. In a subsequent issue we hope to publish an article on pulverized coal as it affects the mining engineers interested in non-ferrous metals, written by Mr. L. C. Harvey, the engineer who investigated the application of pulverized coal in America for the Department of Scientific and Industrial Research. In the meantime we recommend readers to study his report, which was issued recently.

To the ordinary man who is conversant with the difficulties of securing a complete combustion of the carbon of the coal, the burning of the coal as a powder injected into the boiler furnace with a jet of air would seem both to solve the smoke problem and to increase the efficiency of the combustion. He would suppose that complete combustion is secured, that labour would be eliminated, that the regulation of the temperature and distribution of the heat would be improved, and that the clinkering difficulty would be avoided. In such a supposition he is, of course, mostly right, but on the other hand the opponents of the method have brought forward many objections that would confuse him. The system is admittedly not so simple as it seems at first sight, and there are a number of points that require careful consideration. One of these is the cost of pulverizing, and another is the liability of coal dust to spontaneous combustion in bulk and to explosion when mixed with air. Then it is said that the refractory bricks and the tubes deteriorate rapidly, and that it is difficult to control the flame and the temperature. Moreover the accumulation of ash and slag presents serious drawbacks. But to the practical man, who is not afraid of obstacles, these adverse conditions have not acted as deterrents. In spite of all the so-called disadvantages, the system has gone ahead in America, and has proved highly efficacious in reducing fuel consumption, while much coal hitherto considered as waste is now being turned to profitable account. Thus the cost of running the power plants has been substantially reduced and the coal resources of the world are being conserved.

The application of pulverized coal as a source of heat in metallurgical operations, particularly in connection with reverberatory furnaces in the smelting of copper ores, has been described in this Magazine on numerous occasions, notably by Mr. E. J. Carlyle in the issue of September, 1914. More recently its use in copper blast-furnaces has been the subject of experiment, first at the works of the Tennessee Copper Company, and more recently at the Copper Cliff works of the International Nickel Company. The experience gained at these two smelting plants is recounted in the article published in this issue. Success has attended the work to the extent that 50% of the coke can be replaced by pulverized coal, giving a distinct saving in these days of high prices for coke. The results obtained so far with coke entirely eliminated have not been satisfactory, but they are sufficiently encouraging for the experiments to be continued. It has to be remembered in connection with the application of pulverized coal to copper metallurgy that the coal is used for heating and not for the reduction of the metal from its compounds. The reduction of copper oxide by carbon is an unsatisfactory process owing to inevitable losses in the slags, and much better results are obtained by removing the sulphur from copper sulphide by means of oxygen. In iron metallurgy on the other hand the reduction is effected by carbon, and at the present time many experiments are being conducted in this country, the continent of Europe, and America with a view of using blasts containing coal dust or carbon compounds for both heating and reducing. Of these experiments we shall hear more later. Pulverized coal has also been extensively used in steel manufacture and similar metallurgical operations, but these applications do not come within our province.

Before leaving this subject, we would ask metallurgists or power engineers to invent a new word for pulverized coal. Various writers refer to "pulverized coal," "pulverized fuel," "powdered coal," "powdered fuel," "coal dust," "dust coal," "duff," "culm," "rejected fuel," "coal sludge," "coal smudge," "coal screenings," etc. Perhaps some reader will oblige with a suggestion.

REVIEW OF MINING

Introduction. — People have become alarmed at the reckless public expenditure and at the possibility of national bankruptcy or the imposition of severer taxation. Among the wage-earners there is little enlightenment on the necessity for hard work. The tendency to indolence is noticeable in other classes of society. For instance, in mining circles engineers are complaining that the financiers and boards of directors are painfully slow in getting a move on. The freeing of the gold market has been an important event, and will bring a brief period of prosperity to many mines that have been suffering from high costs. On the other hand the new Phthisis Act has added big burdens to the mines on the Rand. Silver has been soaring to a level that brings its market price to its monetary value. Another important event of the month has been the acquirement of the Clifden mineral rights by Tehidy Minerals, Ltd.

Transvaal.—The sittings of the Rand Mining Commission have been completed and the report may be expected shortly. Political events, such as the ratification of the Peace Treaty, may prevent any vigorous action on the part of the legislature, and indeed no such action is immediately necessary owing to the freeing of the gold market. It is not thought that the report will contain any recommendations of financial aid or government control, but that it will be confined to the widening of the recruiting area and the improvement in underground regulations to eliminate delays.

The mines are now able to sell their gold in the most favourable market, and premiums are being received for gold shipped to the United States. With American exchange at $4·25 the premium is 14½%, which will have important effects on the profit and loss accounts of the mines on the Rand, both rich and poor.

As mentioned in a recent issue, the new Phthisis Fund regulations were expected to impose an increased burden on the Rand gold mines. These fears have been fully confirmed, and some of the assessments are distinctly disconcerting. For instance, the levy on East Rand Proprietary Mines is increased from £16,500 to £41,000 per year. At the present time, when the mines are getting a premium on their gold, this additional impost may not be particularly alarming, but as the Phthisis Fund is a fixed liability and the premium on gold is an uncertain factor, the two items cannot be held to counterbalance each other.

The excitement in the Johannesburg market in Modder East shares has continued, owing to the discovery of much high-grade ore. The developments have been so satisfactory that the directors have decided to erect treatment plant, with a capacity of 40,000 tons per month. For the purpose of providing funds, a further issue of £300,000 convertible debentures is to be made. These will be issued at par, and as the present debentures stand at a big premium, there is no doubt about the attractiveness of the offer.

There appears to be some activity in financial circles in Johannesburg having for its object the revival of interest in the far west Rand. Two particular instances may be mentioned in connection with this movement, the Western Rand Estates and the French Rand, respectively. Fifteen years ago a good deal was heard of the former, which was organized by Messrs. D. J. & E. J. Pullinger to prospect to the south-west of Randfontein. A number of bore-holes were sunk, which disclosed two reefs. One hole gave quite promising results, but, generally speaking, the reefs were narrow and of low assay-value. The present does not seem to be the right time for re-commencing operations. If the results at Randfontein took a decided turn for the better, there might be some encouragement to investigate its neighbours once again. As it is, the far west Rand can only be considered as an asset of problematical value in the dim and distant future.

Rhodesia.—The output of gold during July is reported at £214,919, as compared with £214,919 in June and £251,740 in July last year. The monthly returns have been remarkably regular this year, and the failure of some of the old stagers is compensated by the increased output from some of the smaller workings. Other July outputs for Southern Rhodesia are: Silver 13,493 oz., coal 41,521 tons, copper 245 tons, chrome ore 2,679 tons, asbestos 941 tons, arsenic 4 tons, tungsten 3 tons, diamonds 63 carats.

It is reported that Sir Abe Bailey, working through his Anglo-American Rhodesian Corporation, is about to amalgamate the Enterprise, Giant, and the London & Rhodesian Mining & Land companies. A new company is to be formed, with a capital of £2,000,000, of which £331,000 will be issued to the shareholders in the companies named, the Enterprise capital being written down 75% and the capital of the other two by 50%. We have yet to learn what is to be done with the large reserve of unissued shares.

West Africa.—The output of gold for July is reported at £102,467, as compared with £106,612 in June and £117,581 in July, 1918. The Taquah return showed a temporary fall due to a shaft accident, while the Abbontiakoon figure was less than usual owing to ore of lower grade being treated. The output of Ashanti Goldfields is back to normal again. A serious fire occurred last month in the Prestea Block A mine, and all underground work was stopped for three days. Good results of development are reported from the Abosso mine. The West African mines are now free to sell their gold in the best market and substantial premiums are being secured.

Nigeria.—Much has been heard of lead-zinc-silver deposits in Nigeria belonging jointly to the Kwall Tinfields of Nigeria, the Transvaal & Rhodesian Estates, and the Union & Rhodesian Trust. Some particulars, based on information supplied by the manager of the first-named company, Mr. R. Cousin, were given at the meeting in April, as reported in our issue of that month. Further information, based on a cable from Mr. F. H. Lathbury, has been published this month. It appears that several outcrops have been traced, and that they vary in width up to 50 ft. Bulk samples are now being sent home. Further prospecting and examination will be necessary before any idea of the value of the deposits can be obtained.

Australasia.—The strike at Broken Hill still continues. The woodcutters' strike at Kalgoorlie has been settled, but full resumption of work at the mines has been delayed by another outbreak of influenza. The drought has been broken in South Australia and New South Wales, and the position at many mines whose operations have been hampered by scarcity of water is improved accordingly.

Cable advices announce that the profit of the Broken Hill Proprietary for the year ended May 31 was £652,342. At Broken Hill the concentrator treated 120,095 tons of lead-zinc-silver ore, producing 43,358 tons of lead concentrate, while the flotation plant treated 211,438 tons of tailing, producing 48,579 tons of zinc concentrate. At the steel works at Newcastle, the output of pig iron was 155,172 tons, and that of steel ingots 178,000 tons. No. 2 blast-furnace was put into operation on December 5, and afterwards No. 1 furnace was repaired. Unfortunately, since the close of the company's financial year, the shipping strike has cut off the supplies of iron ore, and smelting was stopped on July 11. Two additional open-hearth furnaces are to be built.

It was recently mentioned in this column that the Waihi Gold Mining Co. was contemplating the sale of the Hora-Hora hydro-electric power station to the New Zealand Government. This deal has now been completed. The agreed price is £212,500, payable at a date not yet fixed. The company is being credited with £10,625 per year, being interest at 5%, against the cost of the power it takes from the new owners for use at the mine and metallurgical works.

It is announced that an important discovery of gold has been made on Hampton Plains, West Australia, a district much to the fore in earlier days. Details are awaited.

The Lake View & Oroya Exploration Co. is about to capitalize part of its reserve fund and distribute one 10s. share to the holder of every seven shares. The company's assets, especially the 100,000 Burma Corporation shares, have substantially increased in value recently. If the profit were realized by the sale of these shares, a large proportion would go as Excess Profits Duty. The present plan will give the shareholders some return that will compensate for lack of dividends.

The West Australian Government has announced its intention of introducing a bill to deal with gold-stealing at the mines, based mainly on the law in operation in Victoria. We devoted considerable space in the issue of December last to this question, and detailed the efforts of the mine-owners at Kalgoorlie to secure proper protection against theft. But it seems like locking the stable door after most of the horses have been dispersed.

The Commonwealth Government has decided not to exercise its option on the Blythe River iron mines in Tasmania. We take it that the abandonment of the project is due to present political and economic conditions.

A flotation plant is to be erected by the Mount Read and Rosebery Mines, Ltd., at the Rosebery mine in Tasmania. Development is to be suspended during its erection, as the reserves are large.

A company called Federation Tin has been formed by Melbourne interests to acquire a lode-tin property at South Heemskirk, on the west side of Tasmania. A mill of 60 stamps is to be erected capable of treating 120,000 tons per year. The ore can be easily worked by open-cut, and Mr. J. B. Lewis, the consulting engineer, estimates the known ore at 1,000,000 tons, averaging 1% of tin oxide.

India.—It is reported that arrangements are being made for the conversion of the Burma

Corporation into an Indian company, but no official statement has yet been made. The policy seems a judicious one, seeing that the company is not merely the owner of mines and a lead smelter in Burma, but is arranging for the smelting of zinc ores in central India, and, in co-operation with the firm of Tata & Sons, of Bombay, for the manufacture of brass and galvanized iron. Moreover the company has intimate financial relations with the Indian Government, the latter having advanced £200,000 towards the construction of the zinc works.

Malaya. — Another company has been formed by the Austral Malay Tin Co., to dredge in the Federated Malay States. This is the Ulu Yam Dredging Co., Ltd. The area is 400 acres, and the ground is estimated to contain 13½ million cubic yards averaging 0·76 lb. of tin oxide per yard. A dredge with a monthly capacity of 80,000 yd. is being constructed by Chas. Ruwolt & Co., of Melbourne.

Cornwall.—Particulars of the expansion of Tehidy Minerals, Ltd., by the absorption of the Clifden royalties are given by our Camborne correspondent, and comment is made in the editorial columns. Our correspondent also refers to the Grenville reconstruction. An examination of the Geevor mine has been made by Mr. Josiah Paull, but his report had not been issued at the time we went to press.

With reference to our criticism of Mr. Albert F. Calvert's mining ventures in the Gwinear district, Cornwall, contained in the last issue, we have received the following communication, dated August 22, from Messrs. Ashurst, Morris, Crisp & Co.: "We have been consulted by our client, Mr. Albert F. Calvert, with reference to an article published by you on page 74 of the Magazine for August, containing statements which are entirely inaccurate. The statements you refer to are, you say, to be found in articles or advertisements appearing in certain newspapers, but you must be well aware that they all appeared in an article written and signed by Mr. Herbert Thomas, Managing Editor of *The Cornish Post and Mining News*. It is incorrect for you to say that these statements emanated from Mr. Calvert, as he was in London at the time Mr. Thomas visited the properties and wrote and published his article. It is untrue to say that Mr. Calvert reported that his average assay-values up to date gave 30 lb. of tin per ton on the Trevascus property. Mr. Calvert states most emphatically that he has never given this or any other assay-value in connection with this property, nor has he ever tested, assayed, or valued any ore from this property. If you will refer to the article again you will see it distinctly states that it was Major Bullen who reported the assay-value you criticize, and as the Jumbil Company has erected an up-to-date laboratory and appointed a competent staff for assaying purposes under the direction of Mr. H. R. Beringer, of the Camborne School of Metalliferous Mining, we have no doubt they will be able to justify any figures put forward by them. Your statement that Mr. Calvert bought the registration of the Jumbil Company for the particular purpose of working these properties is also incorrect. Neither he nor anyone else bought this registration, but the company originally purchased a property in Nigeria from Mr. Calvert which produced some tin, but did not turn out as successfully as was anticipated, and although our client was under no legal obligation and was not called upon to do so, he offered to transfer other properties in Cornwall on very favourable terms to the company or to purchase the interest of any shareholder who preferred to sell. These offers he carried out. In view of the fact that the company will next week commence selling tin from these properties, and that the properties are turning out most favourably, it would not appear that the company has made a very bad bargain in taking them over." As regards the source of the statements, it is true that they all originally appeared in an article in *The Cornish Post*. This article was reproduced as advertising matter in other papers. In the case of one London daily the order for the advertisement was refused. It is obvious that the article was based on information supplied by some one in authority at the mines. Mr. Calvert says he did not give the figure 30 lb., but that Major Bullen did. No doubt Mr. Calvert accepts the figure, and from the point of view of the possible shareholder this is much the same thing. With regard to the third point raised, relating to the history of the Jumbil transactions, we accept the correction. We look forward to the regular sales of tin with uncommon interest. It is worth noting that though, on August 22, the company would begin selling tin "next week," it has not yet made its debut at the tin ticketings.

Norfolk.—A brief outline of progress in connection with the development of the Norfolk oil-shales was given by Dr. Forbes-Leslie at a meeting of shareholders of the English Oilfields, Ltd., held on September 1. This meeting was convened for the purpose of sanctioning the increase of capital of the company from £300,000 to £1,500,000, by the creation of 1,200,000 new shares, to be issued as required. Dr. Forbes-Leslie stated that 19 bore-holes have been sunk, and that the ground proved thereby covers 20 square miles. A number of beds have been discovered, one below the other and separated by partings. The total thickness of the retortable material is given at not less than 150 ft. One of the bores passed through 70 ft. of shale high in paraffin wax. Mining operations commenced six months ago at No. 1 Mine West Winch, where the fourth seam of the series is being worked. The sulphur content of the lower seams is much lower than that of the top bed, where, it will be remembered, the shale gave a fuel oil having a sulphur content above the Admiralty limit. The present capacity of the mining plant is 500 tons per day, and is to be increased to 1,000 tons. The reserve of shale indicated by the bore-holes is 2,000,000,000 tons, capable of yielding 45 to 50 gallons of oil per ton, and 60 lb. of sulphate of ammonia. A distilling works, with a capacity of 1,000 tons per day, is to be erected forthwith. Dr. Forbes-Leslie promises a more detailed account of the venture later in the year.

Canada.—Cable advices announce that the strike at Cobalt is over.

Alaska.—Efforts to bring the milling plant of the Alaska Juneau gold mine up to estimated capacity are being vigorously continued. As has been recorded on several occasions, the ball-mills crushed only a small fraction of what was expected, and many experiments have been made to devise improvements in their performance. The latest news is that the cost can be decreased and the capacity raised by converting the ball-mills into the closed-circuit overflow type. Instead of re-grinding oversize coarser than 10 mesh in tube-mills, the oversize is to be returned to the ball-mills. Also, grizzlies are now placed between the gyratory crushers and the coarse-crushing stamps.

A permanent exhibition of mining machinery and metallurgical plant is to be opened at the Grand Central Palace, New York, next month. In a country of long distances such a plan will save much time, and buyers and designers with headquarters in New York will be better in touch with the makers in Chicago, Denver, and San Francisco.

Mexico.—The public outcry against the Mexican Government, particularly in the United States, has roused Carranza to reply, but his statements are not couched in the language of a wise ruler and only serve to render his position more impossible. The British Government is issuing a warning in this country advising that anyone contemplating the investment of money or the purchase of land in Mexico should communicate first with the British Consul in Mexico City before taking any definite steps. The warning notice states that the precaution is necessary on account of the frequent disputes regarding titles to land at the present time. This attitude on the part of the Government is all right in its way, as it may help to focus the present dissatisfaction, but many of us would be glad to see stronger action.

The property of the San Francisco Mines of Mexico, Ltd., is being examined by an American group, not named, with a view to purchase for the sum of $3,500,000. These mines have been before the British public for sixteen years. In spite of the presence of many excellent business men on the board of directors, and the advantage of advice from eminent experts, the company has not been a success, owing chiefly to the complexity of the ores. A new plant with a capacity of 100 tons per day was erected a year ago, its object being the production of a high-grade silver-lead concentrate, but in April of this year the mine and mill were closed owing to the disturbed state of Chihuahua. The company's position is that further capital would have to be obtained for extending the plant. The directors consider the sale of the property advisable, if it can be effected.

The Esperanza company announces that it has exercised its option on the Union en Cuale property, in the state of Jalisco.

Spain.—The directors of the Cordoba Copper Company announce that the sale of the property has been completed, and that the purchase price, one million pesetas, has been received. The company's assets now consist of £70,000 invested in government securities. The directors will submit their proposals with regard to future policy at an early date.

The San Miguel pyrites mine is to be closed and the company liquidated. Several factors have combined to force this decision. The copper content of the ore has been continuously decreasing of late, being now less than 1%. The developments in depth have given poor results, and the known richer ore in the crush below the open-cut is too dangerous to work. The company is saddled with a very disadvantageous contract for the sale of sulphur ore, a legacy from a previous board. Finally, the price of iron required for the precipitation of copper is at a ruinous level. Mr. John F. Allan, the consulting engineer, and Mr. E. Mackay Heriot, the manager, have not been able to combat these adverse conditions.

PULVERIZED COAL IN BLAST-FURNACES.

By E. P. MATHEWSON and W. L. WOTHERSPOON.

We reproduce herewith a paper appearing in the July *Bulletin* of the Canadian Mining Institute, giving particulars of the use of coal dust in blast-furnaces working on copper ores, an important recent development in metallurgical practice.

HISTORY.—The use of pulverized coal in reverberatory furnaces, cement kilns, open-hearth furnaces, boilers, and other similar furnaces, has been dealt with extensively in many papers and publications; the present paper will be confined to the application of pulverized fuel to blast-furnaces, wherein the mixture of fuel and air is injected into the lower portion of a piled mass of material, and combustion takes place under pressure.

Until recently the history of pulverized coal in blast-furnaces contained nothing but records of failures. Sir Lowthian Bell, in his book on the "Principles of the Manufacture of Iron and Steel" published in 1872, which deservedly ranks among the world's metallurgical classics, mentions an attempt to introduce finely divided coal with the blast at the tuyeres in an iron furnace; the attempt was soon abandoned, and Bell remarked that it needed but little consideration to ensure the rejection of all such schemes. About 1902, Mr. W. J. Forster, of Darlaston, England, satisfied himself by a great number of experiments at the Darlaston furnaces "that nothing but failure can be expected from the addition of cold materials into the hearth of the furnace with the blast." Possessed of this opinion, Mr. Forster suggested the use in the blast-furnace of a specially prepared carbon obtained by heating solid carbon to a very high temperature, so that all volatile matter and moisture should be expelled and the carbon should be strongly heated before its use in the blast. He obtained British and American patents on the expedient of so preparing carbon and introducing it with the blast, whereby he hoped to make special grades of iron. The idea seems to have produced no effect upon the art of smelting iron, but it may be considered to illustrate the rest of the history of the use of pulverized fuel in blast-furnaces, as this history consists of sundry comparable suggestions of expedients all of which have, so far as known, failed to meet with practical success. The efforts to use successfully pulverized fuel in iron blast-furnaces have embraced such expedients as the substitution of heated gas, with and without super-heated steam, for some or all of the air; the careful classifying of the fuel into different and distinct sizes with a view to employing the finer grade to create a high initial temperature to ignite the rest; the substitution of an annular reverberatory arranged around the base of the charge, and the injection tangentially thereinto of the powdered coal and air; the grinding and mixing of the charge itself so that the particles might fall through a stream of burning fuel and air, and so on. It is not profitable for present purposes to consider all these expedients or the various patents which have been granted on them, because, so far as is known, none of them has been sufficiently successful to secure adoption.

The results obtained by the recent work which we shall now describe have been attained not so much by resort to extraneous expedients as by the development of the combustion process itself. The chemical phenomena of combustion are relatively little known, although they have been made the subject of important research work by numerous scientists since the days of Bunsen, who, in 1845, made investigations on a coal-fired blast-furnace used for the smelting of iron ores; and it is impracticable, within the limits of this paper, to discuss these phenomena in detail. The phenomena apparently embrace distillation of volatile matter, gasification, and combustion. When a mixture of air and finely divided fuel is directed into and against a mass of more or less refractory material, different results may ensue, according to variations in a multiplicity of factors. The work to be described seems to demonstrate that by proper provision of suitable space for combustion, and maintenance of correct air pressure and fuel supply within the combustion space, it is practicable to develop within the charge a sort of super-combustion, which provides at greatly reduced cost the heat necessary to bring the charge to a molten condition. It is particularly difficult to generalize or define the possibilities or limitations of the generation of heat in a blast-furnace so operated, for much depends upon the physical and chemical characteristics of the charge, as well as upon the variable factors directly entering into the combustion. A better idea of the work may be afforded by concrete illustration. For this purpose we describe work in a field which, we believe, has heretofore been untouched even by suggestion, namely, the melting of copper and the smelting of copper ores.

Mr. Garred became interested in the application of pulverized fuel to blast-furnaces in 1913, but it was two years later when he applied some of his ideas in a practical way, by melting blister copper in a blast-furnace. The design provided special facilities for combustion, and the tuyeres were so arranged that in the event of the charge becoming frozen, they would remain clear. During the experiment, over a million pounds of blister copper was melted. The experiments were particularly interesting owing to the fact that with a furnace of 36 in. diameter, handling large angular pieces of blister copper, it was possible to continue the work to the extent described. In connection with the danger of a charge becoming frozen it might be mentioned that the furnace was allowed to stand over a week end, and was then successfully restored to its normal condition in a short time, by the use of pulverized fuel.

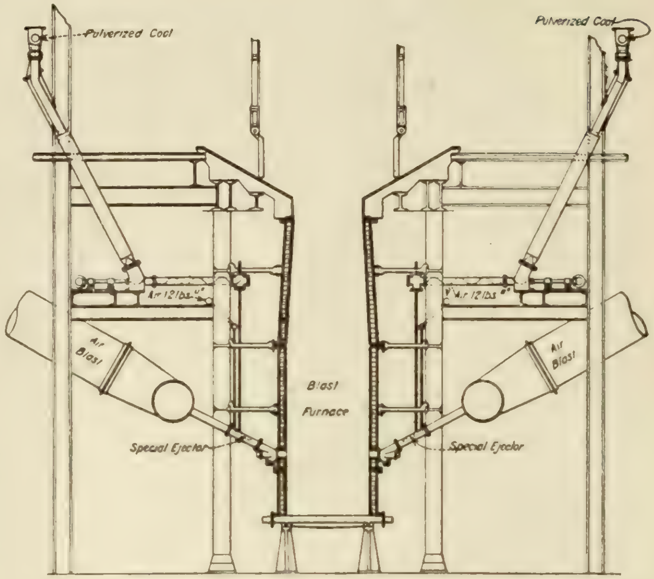
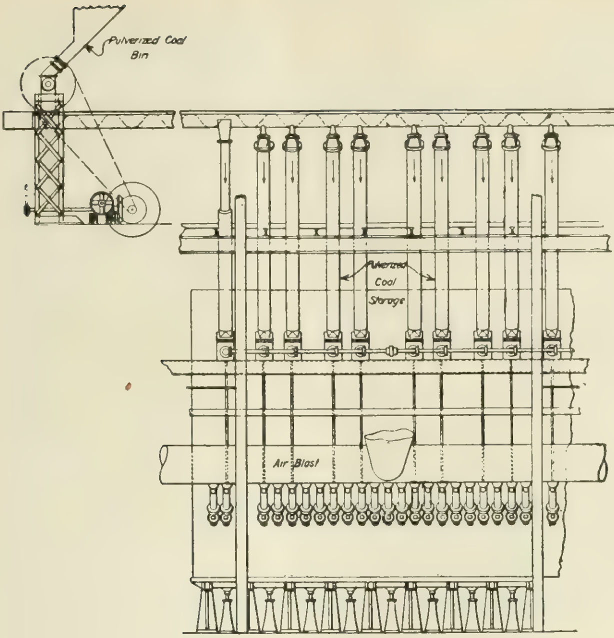


FIG. 1. DIAGRAMS SHOWING THE METHOD OF APPLYING

EXPERIMENTS AT TENNESSEE.—Experiments at the smelter of the Tennessee Copper Co. were decided upon early in 1918, one of their standard blast-furnaces, 22 ft. 6 in. long by 60 in. wide, being used. Ten tuyeres on one side of the furnace were equipped for the use of pulverized fuel, and the first test run of importance started on April 22 and was continued until May 4, during which time the percentage of coal to the charge was 3·8 as against 5·7 of coke used on the other furnaces during the same period, when operating with a similar charge. The second test run started May 9, and continued until May 24, when the percentage of coal used was 3·6, a very small amount of coke being used intermittently. A third test run was then made, feeding a little coke on the side of the furnace where no coal was fed previously, as it had been found there was a tendency for crusts to form on that side of the furnace. It was then decided to apply the coal at ten tuyeres on each side, but experimental work was postponed, owing to the possibility of some unconsumed carbon in the furnace gases causing discolorization and affecting the quality of the acid, which is an important product of the company, particularly during the war, when a portion was used in the manufacture of high explosives. The war requirements in this connection no longer existing, the company returned to the experimental work in January, and are continuing, with various modifications, the methods of applying the coal. As the Tennessee Co. had not used pulverized coal previously, it was necessary to install a coal-preparation plant. A plant with a capacity of three tons per hour was constructed at a cost of about \$35,000. The cost of the feeding apparatus at the furnace was about \$5,000. An analysis of the average ore smelted at Copperhill, Tennessee, during 1918, is as follows: Cu 1·55%; Fe 34·6; S 24·6; SiO_2 20·3; CaO 4·9; MgO 2·0; Zn 1·4; Al_2O_3 4·3. The furnace has 27 tuyeres on one side and 24 on the other and the air blast is maintained at 35 to 45 ounces pressure. Fig. 1 presents a general arrangement showing the method of applying pulverized fuel to the experimental furnace.

EXPERIMENTS AT COPPER CLIFF.—Following the work of Garred, already described, the International Nickel Co. decided, in June, 1918, to carry out experiments in the blast-furnace department of their smelter at Copper Cliff, Ontario. It was decided to utilize one of their standard blast-furnaces, which are 25 ft. 6 in. long by 50 in. wide. The furnace bottom is lined with magnesite brick to within 14 inches of the centre of the tuyeres; the two lower rows of jackets are cast iron with water-cooled pipes, and the two upper rows of jackets are of the standard water-cooled steel type. The furnace has 48 six-inch tuyeres, 24 on a side, spaced about 12 inch centres. These are connected to a main bustle



PULVERIZED COAL AT THE TENNESSEE SMELTER.

The furnace, under normal conditions of smelting, treats about 500 tons of charge a day, using 60 tons of coke, the average coke consumption for six months being 12·5% of the charge.

Regarding air conditions, only approximate estimates were available, owing to the whole of the blast-furnace plant being supplied from a central blower installation. General observations indicated that the furnace charge is kept about 7 ft. deep, and the smelting zone is from 2 to 3 ft. above the tuyeres. Blow-holes form quickly after a fresh charge, but the amount of dust made is about normal, 1·5% to 2% to the ore.

The tuyeres require punching regularly, the method being to remove the tuyere cap, and, by introducing a rod, to ease the ore in the vicinity of the tuyere. It was usual, when cleaning these tuyeres, for some loose ore to be blown out on the furnace floor in a condition which indicated that the ore close to the tuyeres had not been strongly heated. Through the tuyeres, the charge appeared black, and usually there was no appearance of fire until near the middle of the furnace.

pipe with 6 in. galvanized branch pipes fitted with canvas sleeves. The bustle pipe is supplied, by an offset, from the main delivery pipe which feeds seven other furnaces, the normal pressure of air carried at the tuyeres being 23-24 ounces. The furnace charge consists mainly of a refractory copper-nickel sulphide ore, a large proportion of which is delivered from the company's roasting plant. The composition of the charge and the average size and analysis of the constituents and products are as follows:

NATURE OF CHARGE.

	Percentage of charge to blast furnace. Average for 6 months.
Roasted Ore	74·8
Raw Creighton	2·8
Raw Crean Hill	8·0
Total Ore	85·6
Converter Slag	10·2
Converter Scrap	3·2
Limestone and Quartz	1·0
	100·0

SCREEN TESTS.

	%
Roasted ore—on 1½ in.	53
Roasted ore—on 1 in.	16
Roasted ore—through 1 in.	31
Raw Creighton, practically all through ¾ in.	

TYPICAL COMPOSITION OF BLAST-FURNACE CHARGE AND PRODUCTS.

	Cu %	Ni %	Fe %	S %	SiO_2 %	Al_2O_3 %	CaO %	MgO %
Roasted Ore	1·40	4·10	38·50	11·75	20·25	4·50	2·25	2·50
Raw Creighton Ore	1·40	3·90	39·50	23·00	21·00	5·25	2·50	3·00
Raw Crean Hill Ore	2.50	1·75	24·00	11·50	32·00	10·00	5·00	5·50
Converted Slag	1·00	3·00	47·00	2·40	26·75	3·00	1·25	1·50
Scrap Charged	2·25	6·00	42·00	2·00	21·75	2·00	·75	1·50
Limestone	...	...	1·00	...	2·50	...	52·75	1·10
Quartz	...	...	3·00	...	91·00	2·90	1·00	1·00
Blast-Furnace Matte	5·85	14·35	48·40	26·25				
Blast-Furnace Slag	0·16	0·32	40·90	1·65	33·15	6·50	3·70	2·50

The usual practice is to make up a furnace charge consisting of certain proportions of roasted ores, green ore, by-products such as converter slags, and coke, all being dumped into the top of the furnace from small cars in such a way as to give an even distribution in the body of the furnace. Under these conditions of intermittent charges of the fuel, the regularity of its distribution is not easily obtained.

Arrangements for conducting the experiments were greatly facilitated because the company had used pulverized coal in reverberatory furnaces since 1911. The coal preparation plant, however, was 1,100 ft. from the blast-furnace, and the first problem was how to transmit the coal. Attempts were made to transmit the coal in pipes by means of ejectors, but, although the results obtained were interesting, they did not meet the particular problem satisfactorily. Compressed air was then used for displacing the pulverized coal from storage tanks, and it was found that 2½ tons of coal could be transmitted in five minutes through a 3 in. standard wrought iron pipe, 1,100 ft. on the horizontal and with an elevation of 50 ft.

The feed or service bins at the blast-furnace

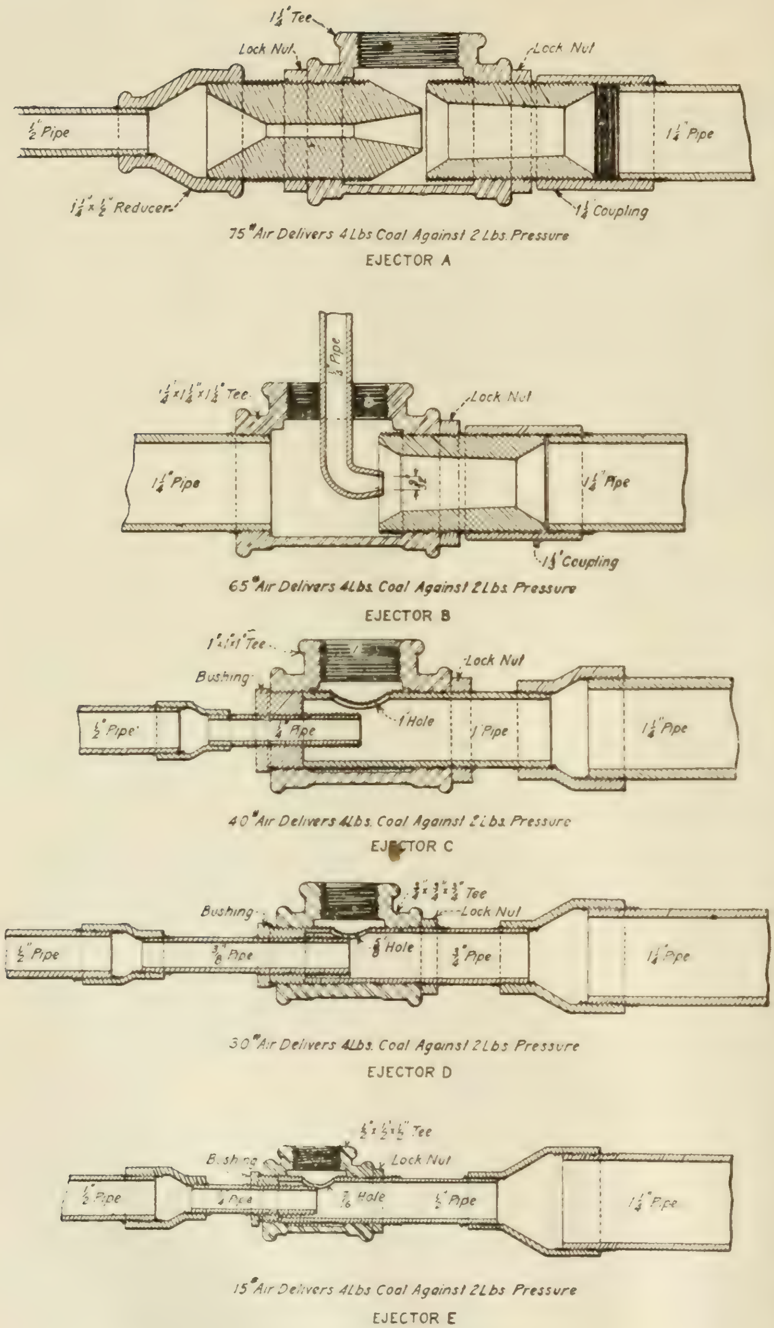
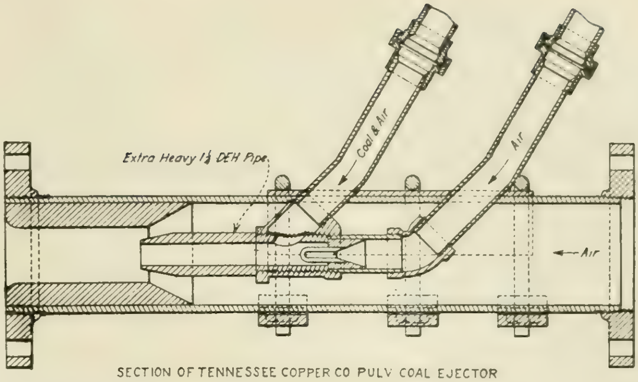


Fig. 2. Various Forms of Ejectors.

are about 13 ft. long, 3 ft. wide at the top, 14 in. wide at the bottom, and about 6 ft. deep. They are constructed of No. 14 gauge steel plate, and are completely closed, a manhole being provided, and an air vent pipe to which a cyclone separator is fitted. The bins each hold about $3\frac{1}{2}$ tons of pulverized coal. At the bottom of each are twelve common screw feeders, operated from a line shaft through bevel gears, each feeder having a small clutch, the line shaft being driven from a variable speed motor. The feeders can be operated satisfactorily at speeds between 40 and 100 r.p.m., to deliver from 3 to 6 lb. of coal per minute; and any individual feeder can be stopped without interfering with the general operating conditions. The screws are made of special length and pitch, being made in a lathe. In calibrating these at different speeds for the discharge of the coal, no flushing effects have been noticed. This arrangement of feeding the coal is positive, sufficiently accurate, and mechanically simple. The twelve feed screws at each bin discharge the coal into $1\frac{1}{4}$ in. diameter pipes which are in turn connected with the blast pipes or tuyeres at the furnace, the coal being transmitted by ejectors, using a small quantity of high pressure air, which is beneficial in the mixing of the fuel and air for the furnace.

Experiments have been made with a number of ejectors, the design of which is important, when giving consideration to economy in the use of compressed air. Easily constructed ejectors may be made from standard pipe fittings, by proportioning the sizes, but the size and proportion of the inlet of the compressed air to the discharge of the ejector is a most important feature. Some of the ejectors used are shown in Fig. 2.

In commencing the experiments, the air blast for the combustion of the coal and for smelting was furnished in the regular way under normal operating pressure, and the pulverized coal was introduced directly into the blast before entering the tuyere. It was found that the coal could be introduced very rapidly in this way while the furnace had its regular charge of coke and ore, but when the coke was cut below 50% of normal, it was found that the tuyeres became closed, coal dust would lodge in the tuyere pipe, causing trouble at any leaky joint, thus rendering the condition around the furnace more or less dangerous. At this time the joints between the furnace jackets and the tuyeres were not as tight as they should be, and there was considerable leakage of coal dust. Tuyeres of several designs were tried to avoid leakage, and the canvas sleeves on the branch pipes were replaced with standard pipes, having flexible joints. Improved results were obtained in this way, and some of the tuyeres used are illustrated in Fig. 3. Later on, the coal was introduced to the blast by means of an ejector like that used by Mr. Cavers at the Tennessee Copper Company's plant.



SECTION OF TENNESSEE COPPER CO PULV COAL EJECTOR

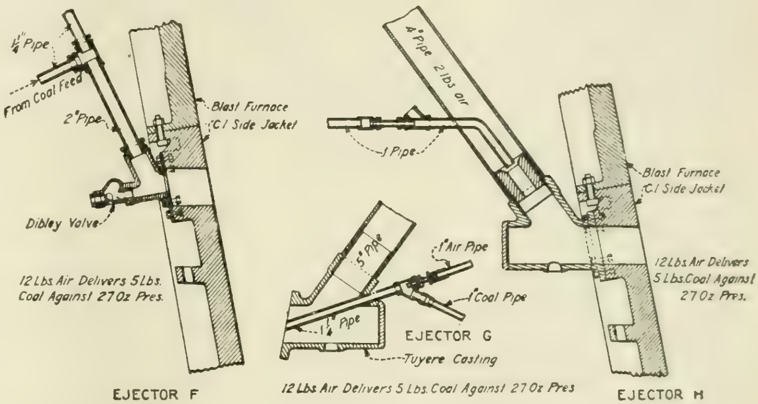


Fig. 3. Various Forms of Tuyeres.

During this stage of the experiments, the main troubles were at the tuyeres, which required regular punching, and there was some leakage of coal. The coal was applied to only half the tuyeres on each side of the furnace, being introduced to alternate tuyeres, those on the front of the surface being staggered in relationship to those at the back. Mr. Garred experimented with check or explosion valves, which were placed in the branch pipes. It was found that these check valves were not effective except when they were carefully designed and placed in every branch pipe, and this was a complication of apparatus that was not considered desirable. It was then found that if any individual tuyere was choked, the coal was drawn into the bustle pipe by suction and found its way down the branch pipes leading to tuyeres that were open. It was therefore agreed that any possibility of explosions could be effectively prevented by arranging check or explosion valves in the bustle pipe itself. The experiment was then made of introducing the coal between and slightly above the tuyeres, by boring a hole through the jacket and connecting to these the coal supply pipe from the ejectors at the screw feeds, thus introducing a dense mixture of coal and air into the furnace independent of the main air supply. This was found to be a clean method and a test was made over a period of eight days. During this time the coke was reduced from 12% to about 6%, with promising results, the most important and necessary condition still being that of keeping the tuyeres open. It was observed that the small openings (1½ in. pipe) through which the coal was introduced into the furnace required very little punching, the main trouble being with the large tuyeres; and by observation through the Dibley valve, the combustion and the smelting of the ore in the furnace could be seen in operation.

It was decided to use specially designed furnace jackets at the tuyere level of the furnace. The design finally adopted is shown in Fig. 4. These jackets, it will be seen, provide means for a more even distribut on of the blast, and it was thought that they would give better opportunity for combustion at the entrance to the charge. It was also believed that furnace jackets designed on this principle would not be more expensive than those of regular design, as two tuyere castings with their joints and machine work would be dispensed with. The furnace is now equipped with some of these jackets, but it is too early to state, definitely, how advantageous they are.

Experiments have been made with a standard blast-furnace reduced in width from 52 in. to 36 in. at the tuyere level, with the air blast at various pressures, and melting a variety of furnace charges. Considerable study has also been given to modifying the design of furnaces in order to obtain ideal conditions in smelting. Fig. 5 illustrates one of these modifications, which it was found could be easily obtained by changing the section of the jackets in the existing furnace at the International Nickel Company's smelter.

These modifications should be advantageous for these reasons:

(1). There will be produced, mechanically or artificially, a condition wherein the melting zone is fixed in proper relation to the combustion and charge.

(2). The tuyeres will be free and unobstructed, giving improved conditions with reduced costs.

(3). The most efficient use of air blast will be possible, on account of its complete control, regulation and distribution.

(4). There will be a combustion chamber and tuyeres so arranged that the gaseous fuel can be used efficiently; among such gaseous fuels may be included pulverized coal and atomized oil.

(5). The furnace construction will cause the

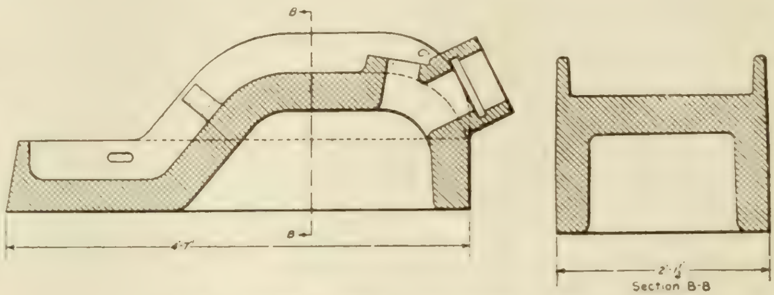


Fig. 4. Furnace Jackets at the Tuyere Level.

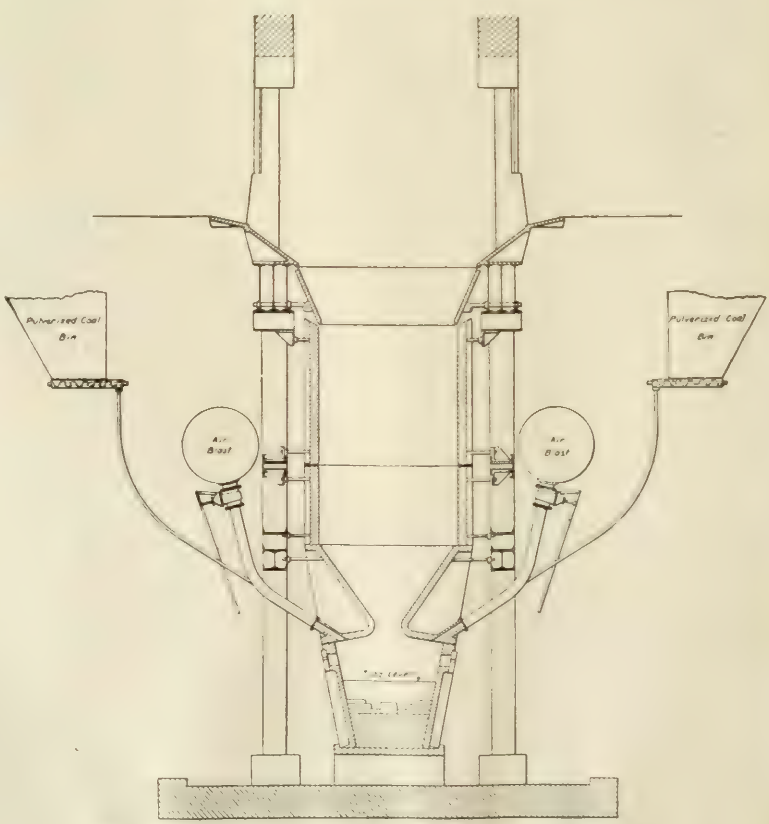


Fig. 5. Modified Form of Blast-Furnace using Pulverized Coal.

gases from the combustion chamber to be distributed efficiently to the furnace charge. Combustion arrangements are such that positive ignition of all the fuel is assured.

(6). The molten mass in the crucible will be strongly heated to facilitate the separation of the metals.

(7). The furnace construction can be so arranged that concentrates, flue dust, fines, etc., can be smelted economically and with minimum losses by being introduced into the lower part of the furnaces by means of the tuyeres or other suitable connections.

(8). There will be the utmost economy in the use of air blast, with resulting economies in power, and there will be a greater efficiency in the use of oxygen, due to the pre-heating of the gases and their better distribution.

(9). The furnace may be rectangular or circular, with the melting zone arranged correspondingly.

(10). With a furnace of this design, combustion occurs at the base of the furnace charge, thus obtaining the most efficient use of the heat and gases.

(11). The furnace design provides facilities for repairs to the lower portion of the furnace without resorting to the usual procedure of shutting down and digging out the whole of the furnace charge.

To summarize the results of the experiments at Copper Cliff, it can be said that under difficult conditions, and without interfering with production in the slightest, it has been demonstrated that important economies are possible at many smelting plants by the use of pulverized coal, thus replacing a considerable portion of the coke, and the International Nickel Company, early this year, decided that an aggressive policy of experimentation and development should be followed.

Operating Conditions and Costs.—It is a foregone conclusion that the characteristics of the charge will have an important bearing on the results obtained. At Tennessee the charge consists of run-of-mine ore and quartz in large pieces, with a high percentage of sulphur, and melting conditions that call for relatively small quantities of fuel. At Copper Cliff, the ore is comparatively fine, over 74% of the charge coming from the roasting beds from which it is reclaimed and handled two or three times, and the final sulphur content does not much exceed 12%.

There are some blast-furnaces operating in conjunction with reverberatory furnaces, where the blast-furnace charge is favourable for easy smelting conditions, due to the slags and other by-products being treated therein. It is generally believed by those conversant with the experiments that successful work at Copper Cliff can assuredly be followed by successful work in a large proportion of the blast-furnaces smelting non-ferrous ores elsewhere.

Regarding blow-holes in the charge, it appears that these should be less when using pulverized fuel than under normal operating conditions, as segregations of the coke are, to a large extent, responsible for the blow-holes. For the same reason, beneficial results might also be anticipated regarding dust losses.

It is often stated that large pieces of incandescent coke are necessary in the charge to support the burden. This may be so under certain conditions, but the experiments indicate that it is not essential in smelting copper sulphide ores, and we do not expect it to be a matter of great moment when treating other non-ferrous ores.

Another point of great importance is the effect of the Garred-Cavers process on the tuyeres and the amount of tuyere punching. Tuyere punching, under normal conditions, entails a good deal of hard labour, and it is our opinion the conditions in this connection will be greatly improved. The moisture content in the charge may be high without causing trouble, during the experiments several charges of wet fines, the clean-up from storage bins, having been handled without trouble.

In the preparation of pulverized coal it is customary first to reduce the run-of-mine product, when this is used, to about one inch in size, preparatory to drying, and then to reduce the powder in pulverizers. The first precaution should therefore be to remove any iron or steel from the coal, by means of magnetic separators. The next precautionary measure is to employ a type of dryer that does not allow the coal to accumulate in large settling chambers, to guard against overheated bearings, and to have the dryer fired and controlled in such a manner that its temperature is under control at all times. It is also important, in arranging conveyors and elevators, to see that pockets and other spaces are not left for the accumulation of pulverized coal.

Coals high in sulphur and moisture content are liable to spontaneous combustion, and it is therefore advisable that bins should be made of metal, totally enclosed, with no corners or pockets where the coal is likely to lodge and stay for any length of time. Storage capacity should be as small as possible, compatible with uninterrupted service.

Danger of explosion occurs when the atmosphere is charged with finely divided fuel, and overheating, through accidents or negligence, causes combustion. It is claimed that sparks alone will not ignite the coal dust air mixture.

Pulverized coal is much safer than oil or natural gas, as a leak is easily detected by the eye, and the trouble can be quickly remedied. The entire system, from the point where the coal is dried, to the tuyeres at the furnaces, can be entirely enclosed, and the bins and conveying system contain but a small quantity of air, so that the danger of explosion is negligible.

It is safe and good practice to blow pulverized coal through comparatively small pipes, and there are several successful installations where the fuel is transmitted long distances by the Bonnot system, the coal being carried in suspension, with about one-third of the volume of air necessary for combustion.

With blast-furnace tuyeres in good condition for operating, there should be no risk of explosion, but check and relief valves should be installed to guard against such a contingency, in the event of interruption of the blast pressure. Automatic controllers should be used to stop the coal feed under such circumstances.

Regarding the ratio of furnace capacity to hearth area, it is too early to state anything definite.

There is consumed, in the United States, about ten million tons of pulverized fuel per annum, and its use is still further being increased, so that there is now an established practice in the preparation of the fuel.

The most important influence on operating costs is in connection with the fuel used, the normal practice being to use coke only, whereas these experiments show that coke can be replaced, to a large extent, by pulverized coal. The relative costs of coal and coke vary a great deal, but, on the average, coke may be stated to cost twice as much as coal delivered at the smelters. It is only necessary to refer to the fuel conditions in Canada to appreciate this phase of the problem. For instance, the International Nickel Company of Canada consumed, in connection with their blast-furnace plant at Copper Cliff, during the last few years, about 300 tons of coke per day, the average cost of this product during the year 1915-16 being \$6·25 per ton. The price of high-grade bituminous coal, as used by them in connection with reverberatory furnaces, had a corresponding cost of \$3·50 per ton of slack. Up to the present, high-grade bituminous coal has been used in the experiments. The average analyses of this coal during the month of August, 1918, which average may be said to be fairly representative, was: fixed carbon 51·85%, volatile matter 36·10%, ash 12·05%, and sulphur 3·28%; fineness 93% to 94% to pass a 100 mesh screen, and 75% to 85% to pass a 200 mesh screen. It will undoubtedly be possible, however, to develop the use of a large variety of pulverized fuel for blast-furnace operations, as has been the case with boilers and other types of furnaces. Lignite will be suitable in many localities, among which are certain portions of Canada, Mexico, and Burma.

In blast-furnace smelting of copper ores, the ash content of the fuel is of minor importance, and the more erosion in a furnace charge the greater the efficiency, so that these two factors connected with the used of pulverized coal, which are discussed so freely in connection with other furnace applications, are here of little significance. The influence on power costs should be favourable, owing to the increased efficiency in the furnace, and the possibilities of more regular charge reducing the wastage of air. The amount of power used for applying the coal at the furnace is small, being confined to the feeders and other apparatus, such as ejectors, etc. The air supply will naturally vary according to the character of the furnace charge and the height of the column that is found to be advisable. The present work has been carried on with the same air pressure and the same height of charge as is usually employed at these smelters; but if higher pressures are used, it is anticipated that the additional cost of power will be more than met by the increased efficiency in the smelting operation.

The introduction of the fuel at the tuyeres gives considerable relief on the charge floor of the furnace, and in a large smelter should have favourable effects on the cost of tramming, the coke being usually handled in cars or other mechanical devices, from storage bins, and this requires an appreciable amount of labour, power, and equipment.

The cost of preparing pulverized coal will vary considerably, as there are several factors bearing on the matter, among which are labour, power, fuel for dryer, repairs, in addition to interest and depreciation on buildings and equipment. The power required for crushing, drying, elevating, and conveying the pulverized coal will be about 20 horse-power-hours per ton of coal handled, and with modern equipment under average conditions, the cost will be about 8 cents per ton per hour. The cost of operating the dryer will depend upon the cost of the fuel, as the amount required per ton of coal dried, with a given moisture content, with standard dryers, will not vary much. The cost of labour will be directly affected by the equipment installed and the size of the plant. The costs from several plants, with a capacity of from 5 to 10 tons per hour, varies considerably. The records for 1912, at the American Iron and Steel Manufacturing Co. of Lebanon, Pennsylvania, show 40c. per ton for the actual preparation of the coal, on a basis of 150 to 200 tons per day, and 20c. for the conveying system, which, in their case, is of an extensive character, owing to the large number of furnaces to which pulverized coal is applied.

The details are as follows:

	Rate per ton of coal produced.
Fuel	\$0·034
Repairs to buildings	0·002
Operating	0·145
Power (steam and electric)	0·221
Repairs to machinery and equipment	0·200
	\$0·602

At the International Nickel Company's smelter, the average cost of preparing and delivering the coal to the furnace in 1913 was as follows:

Labour	\$0·15
Power	0·10
Repairs	0·145
Coal for drying	0·055
	\$0·45

The present costs are abnormal, due to war conditions, and will undoubtedly be reduced in the near future. They are as follows:

Labour (6 months)	\$0·384
Power (June to November, inclusive, 1918)	0·084
Repairs	0·284
Coal for drying (101 tons per day average)	0·108
	\$0·860

In this connection it may be stated that the cost of drying is excessive, because the moisture content of the coal averages about 10%, and that the amount of labour employed could conveniently prepare a much larger tonnage of coal. The item "repairs" includes all repairs to coal crackers, grinders, conveyors, fans, belting, etc. Four men on an 8 hour shift are all that are necessary to prepare and deliver 100 to 200 tons per day.

The costs in connection with lignite are, of course, greater than with other fuels, due to the large increase in dryer costs on account of the moisture. This, to a certain extent, is compensated for in reduced repair cost to pulverizing machinery, as lignite is easily ground. Some of the average operating costs, under recent conditions, are reported as follows:

Small plants (2 to 5 tons per hour), \$1·20 per ton.

Medium plants (10 to 15 tons per hour), 75c. per ton.

Large plants (20 tons and over per hour), 45c. per ton.

The preparation of lignite calls for more attention than that of other fuels, on account of the high moisture content, which is frequently in excess of 50%, and on account of the large amount of volatile constituents. It is usual to reduce the moisture to about 6%; to attempt further reduction is to invite trouble in the way of fires and excessive dryer costs, and all to no avail, because it will again absorb this much moisture from the atmosphere. Various tests show that lignites lose $2\frac{3}{4}$% of their volatile combustible matter, when exposed to a temperature of 214°F. for a period of 30 minutes. Such losses cannot be allowed, and so the drying must be done at lower temperatures, and therefore with increased equipment, recent practice being to arrange the dryers in series.

We have prepared a table showing the approximate costs of plants of different capacities with certain costs as a basis:

Daily Capacity in net tons per 24 hours.	No. of mills required.	Total cost. \$	Building only. \$
20	one 33 in.	34,000	5,500
50	one 42 in.	40,700	7,500
100	three 33 in.	49,500	10,700
200	three 42 in.	66,000	12,500
300	two 57 in.	79,200	14,750
400	three 57 in.	92,500	15,300
500	four 57 in.	106,700	16,000
750	five 57 in.	143,000	19,000
1,000	seven 57 in.	177,000	21,750

These costs are for complete plants, but there should be added 10% for engineering. They are for January, 1919. The estimates are for construction in the eastern or middle regions of the United States.

We also include the distribution of an estimate for a coal plant of 500 tons per day, 336 tons capacity in 16 hours, electrically driven:

Building 32 ft. by 120 ft. erected:	\$	
Structural steel	10,200	
Corrugated roofing	[illegible]	
Corrugated siding	1,400	
Louvres	648	
Steel windows and doors	1,650	
Concrete foundations	1,200	
Excavations	200	
		\$16,080
Machinery:		
Steel track, hoppers, grating, plate feeder, etc.	1,000	
Single roll coal crusher	1,410	
Motor for coal crusher	[illegible]	
Steel cased elevators	4,266	
Motor drives for elevators	1,720	
Magnetic separator	[illegible]	
Storage bins and supports	2,000	
Crade feeder with driving mechanism	750	
Rotary coal dryer with exhauster, dust collector, piping, and motor drive	12,670	
Brick work for dryer	1,400	
Pulverized coal equipment for dryer	1,500	
Screw conveyor with trough	700	
Three 20 ton bins above mills, with discharge spouts, bin gates, and spouts	4,571	
Three 57 in. mills with pulley drives, motors, and belts	31,260	
Steel platforms, runways, and stairs	4,000	
Discharge spouts from mills	300	
10 ton crane	1,500	
Screw conveyor with motor drive	620	

	$	
Conveyor cover, exhauster, dust collector, and piping	1,900	
Wiring and installation of motors	4,000	
Machinery foundations and floors	3,150	
Excavations	1,000	
Miscellaneous erection, labour	3,750	
		85,458
Total		$101,538
Engineering 10%		10,150
		$111,888

GENERAL.—The experiments described give a general outline of the work done by Garred and Cavers, and the authors have presented general information obtained to date. The experiments of the Tennessee Copper Company are continuing with encouraging results, and at the plant of the International Nickel Company the most recent work has been to endeavour to operate the furnace entirely without coke following earlier work where an average of about 50% of the coke had been replaced. The results, with all coke eliminated, have not as yet been satisfactory, but are sufficiently encouraging to continue the experiment with that object in view.

The processes involving the application of pulverized fuel to blast-furnaces have been patented in the United States, Canada, and many foreign countries, the patentees, Garred and Cavers, both being engaged in work connected with the smelting of non-ferrous ores, and both simultaneously working on practically the same problem, of the combustion of finely divided fuel in a blast-furnace. Owing to the magnitude of the problems involved, a consolidation of their interests was effected recently by the formation of the Garred-Cavers Corporation, New York, which company has acquired the patents issued and pending in connection with this work. It is expected that experiments on the smelting of silver-lead ores will be commenced in the near future, and we have every reason to believe the prospects are good for increasing the efficiency of blast-furnace practice.

During the last few years, some twenty to thirty million tons of non-ferrous ores per year have been treated in blast-furnaces in the United States, Canada, and Mexico, and it is believed that further developments of a satisfactory nature in connection with this work will enable a large proportion of these ores to be smelted with considerable economies in fuel consumption.

[The subject of pulverized fuel as applied for metallurgical and power purposes is discussed elsewhere in this issue.—EDITOR.]

DIAMOND DISCOVERY ON THE GOLD COAST.

This article contains Mr. A. E. Kitson's account of his discovery of diamonds on the Gold Coast, to which short reference was made in the August issue.

IT was announced recently that diamonds were discovered by Mr. A. E. Kitson, Director of the Gold Coast Geological Survey, in the shallow quartz-gravels of the Abomo stream and the adjacent ridge, near the village of Abomoso, on the Birrim River, at a point about 15 miles to the north-west of Kibbi, in the district of Akim Abuakwa, and some 65 miles to the north-west of Accra, the capital of the Colony. Mr. Kitson's report, which was published a few weeks ago by the Gold Coast Government, is given below, with certain modifications embodying the recent official announcement of the Colonial Office relating to the discovery.

On February 4 last, while bicycling down the slope of the low rise on the eastern side of the Abomo Su, on the road from Asunafo to Abomoso, Mr. Kitson saw some angular quartz-gravel in the gutter, and decided to test it for gold. Three small panfuls were collected, panned in the Abomo near by, and two small diamonds with some gold, including one good speck, were found therein. Five small pans of gravel from the bed of this very small swampy stream were also concentrated and one more diamond was found. During the following six days numerous places on the low ridges and the Abomo Su flat were tested by panning with a view to trace the distribution of the diamonds. Altogether 325 diamonds, most of them very small, were obtained, chiefly from the gravel in the bed of the Abomo Su. Most of the work was done away from the channel of the stream, otherwise many more diamonds would have been found.

A tour extending over eleven days was then made to Kade Mountain and back to Abomoso, via Asunafo, through the country to the north-west of Abomoso, in order to test it for diamonds. During this tour a few small diamonds were found. Seven of these came from the Bwano Su, 4 miles away; twelve from the Asikawkaw Su, from three places, 6 miles, $6\frac{1}{4}$ miles, and 10 miles away; three from the Kadewa Su, 14 miles to the north-west; and two from the Akwasi Su, one mile north-east.

On return to Abomoso, 21 pits, varying from 5 to 10 ft. in depth, were sunk into bedrock at various places on the Abomo flat and on the adjacent low ridge to the east of it.

Numbers of small pans of gravel and sand were washed from different layers in these shafts, and from the surface soil near them, and some 45 diamonds found. None of these was found in the bedrock; all of them came from the material overlying it. This later work proved the distribution of the diamonds over a length of $1\frac{1}{2}$ miles along the Abomo valley. The bedrock in some cases proved to be decomposed phyllites (altered slates); in others a decomposed volcanic rock with chlorite, or tuffs. All of them belong to the Birrim Series.

Some 620 diamonds have been found merely by panning during the time the surrounding locality was being tested with regard to the origin and distribution of the diamondiferous gravels. Of these about 530 came from the gravels of the Abomo Su. This might appear as if the stones had been naturally concentrated to a considerable extent in the stream-bed; but that is probably not so, for in the pool at the road crossing the native women have washed the gold-bearing material taken from the slopes of the eastern ridge. Since, however, the stream is little more than a trickle except during the height of the rainy season, there cannot be much concentration of this calabashed material; hence the average yield from the stream-gravel should not be much better than that from the gravel on the rise at the site of the original discovery.

Many of the diamonds are beautifully perfect crystals, colourless and transparent, the commonest forms being the octahedron and the rhombic dodecahedron. A few are of pale yellow, blue, green, grey, and brown tints; others are colourless, but with small dark inclusions. Cleavage plates of octahedra occur in fair numbers, some of them by their size indicating that the original crystals were much larger than any of those found. Many are more or less chipped, as if due to damage during transport by water, while there are many fragments.

All the stones found up to the present are small, averaging approximately 30 to the standard carat, the largest being about $\frac{1}{5}$ carat. In value they vary from 10s. to 12s. per carat for the smaller grade; 17s. 6d. per carat for the medium grade; and 30s. to 32s. 6d. per carat for the larger grade. This is for mixed samples, including all qualities of stones. Some of the largest, however, are worth from 70s. to 80s. per carat.

The gravel which contains the diamonds is usually coarse, with a good deal of quartz; the fine sand is as a rule barren. The concentrate is scanty, consisting of quartz, topaz, zircon, black sand (undetermined), a little red garnet, brown corundum, ragged and partly-worn gold (coarse and fine), odd fragments of rutile and black tourmaline, and numerous small flat elliptical crystals (undetermined) of pale bluish-grey colour, but white when bleached. The general character of the diamondiferous gravel and the concentrates therefrom suggests their derivation from a granite-pegmatite area, but much of the quartz and the gold are undoubtedly of local origin. Much more work needs to be done before the origin and the full distribution of the diamonds can be proved.

The diamonds may have been derived indirectly or directly (as in South Africa) from some volcanic rocks (now concealed) which were intruded as plugs and flows into the Birrim Series during the deposition of the beds of that series, or at a later time; or they may have been formed in pegmatite dykes or along a contact between intrusive granite and the Birrim sediments; or they may have been derived from a pre-existing diamondiferous conglomerate, or from an existing one of the Birrim Series.

One of the pits sunk on the high-terrace pebbly gravels of the old bed of the Birrim River, near Abomoso, yielded one diamond from a small part of the material in it that was panned; while in the Anasso Su, close to the Birrim River, some 5 miles to the north-east, I found one diamond larger than the average of those at Abomoso. This indicates that the Birrim River gravels are diamondiferous, though to what extent remains to be proved. But the peculiar character of the diamond-bearing gravel on the eastern slopes into the Abomo Su, where there is no definite Birrim gravel, raises the suspicion that some at least of the stones may have been locally derived.

The mode of panning necessary to detect the diamonds is different from that for gold. Many of the larger stones, especially those more nearly approaching a round shape, such as the octahedron and the rhombic dodecahedron, roll easily out of the pan long before the concentrate has been obtained; while all the stones float quickly away on the water if the pan becomes partly dry on the bottom. Panning needs to be done in a good light, preferably a strong diffused one, and the pan needs to be tilted frequently from side to side and slowly forward so as to get flashes from the stones. Panning in deep shade is, therefore, almost useless; while strong sunlight gives strong flashes from many minerals, and causes confusion.

THE EVOLUTION OF ORE DEPOSITS FROM IGNEOUS MAGMAS.

By W. H. GOODCHILD, A.R.S.M., M.Inst.M.M., F.G.S.

A Discussion and Reply.

At the June meeting of the Institution of Mining and Metallurgy, Mr. W. H. Goodchild read a paper introducing his theory of the origin of ore deposits, the paper being in the nature of a brief summary of his views put forward in the series of articles appearing in this Magazine from February to October, 1918. The paper was discussed at some length by many eminent geologists and mining engineers, as recorded in our July issue. A full report of this discussion, together with the author's reply, is printed in the Institution's *Bulletin* for August. We extract in the following paragraphs the parts of the discussion that appear to be the most helpful, together with the author's replies in brackets.

Mr. E. T. McCarthy said that the subject was so vast and complex and had been so little studied from the metallographic point of view that the paper opened up to most of them a new field of study, one which would give rise to much controversy and even antagonism; nevertheless, he made bold to prophesy that it would prove revolutionary, as he believed it gave the explanation of the origin of many mineral deposits, although not doing away altogether with some of the old theories. Those old theories would still hold good to a great extent, but were more applicable to secondary deposits derived in the first instance from the author's primary ones.

In the evolution of igneous rocks by magmatic differentiation the author traced the changes which occurred in the melt from that of precipitation, the main source of contact deposits, down to the ultimate and complex sub-magmas which constituted the source of many other ore deposits. The author set out with the statement that primary rock magma was evolved periodically over large areas beneath the earth's crust by direct oxidation of elemental Mg, Ca, Fe, Al, K, Na, Si, etc., the process being powerfully exothermic and expansive and in the nature of an annulment to the general cooling process of the earth, and he would like to ask him to dilate a little more fully on the proofs or methods of deduction by which he arrived at the existence of his original melt, because it appeared to him that if the author could reasonably establish its truth most of his subsequent deductions would be incontrovertible.

Again, what would be the source of the oxygen needed for its conversion into that highly exothermic condition? It was difficult to conceive that the small quantity of water, or elements of water referred to, would be sufficient to oxidize such enormous masses of the melt. The author referred to that process of direct oxidation as being powerfully exothermic and expansive and said that the CaO, K_2O, Na_2O, etc., so formed was present in high-temperature or anhydric forms in contradistinction to the low-temperature forms commonly present in larger proportions in the magmas subsequently produced by crystallization differentiation. He would ask the author to elucidate a little more clearly the cause for that exothermic condition, because it was difficult to conceive how the pyroxene swarm of crystals which the author stated were in an anhydrous state could so exist with the liberation of water or steam which resulted from that fractional crystallization, although it was true that at a later period regeneration did take place in a highly exothermic manner.

[As regards the origin of primary rock magma, I do not think I can add much to the presentation of the subject given in *The Mining Magazine*. It was based on the same fundamental physico-chemical principles as applied to the cooling of rock melts. It is generally accepted that the interior of the earth is made up of matter in the metallic and elemental conditions. Clearly this elemental complex is surrounded in some way or other with a rocky shell. If one wanted to conserve the heat energy of a mass of metal one surrounded it with a non-conducting lagging, and it is precisely in respect to this heat conductivity that the earth's shell differs so markedly from its interior. If one had a huge heated mass of mixed metals and their dissolved gases and it was radiating off heat energy into space, an obvious way of retarding this loss of energy would be to develop a non-conducting or only poorly conducting coating. Now that was precisely what the Le Chatelier law told them a complex heterogeneous mass of elemental substances would be likely to do. Looking at the structure of the earth in this way as displayed by cosmic investigations one could understand at once why we find a non-conducting shell surrounding a high density interior. By further refinements, that is to say, by evolving the non-conducting material periodically and exothermally in the fluid state, and making the fluid crust itself to some extent self-heating by means of allotropic changes, in fact by the continued application of the Le Chatelier law to the whole series of events, one arrived at the hypothesis of primary rock magma formation I have put forward. It is gratifying to note that Mr. McCarthy thinks that if this hypothesis of primary rock magma is sound, then most of my subsequent deductions are incontrovertible. W.H.G.].

* * * *

Dr. J. W. Evans said Mr. Goodchild considered that 2% of water was perhaps a very large amount to be present in a magma, and there might not be so much. He should have said himself that, in the average magma, 20% by weight of water and other volatile constituents would have been very much nearer the truth.

[With Dr. Evans' suggestion of 20% water for an average rock magma, I cannot agree, nor do I think he will find any support for such an extremely high proportion of water among petrologists generally. The known facts of igneous metamorphism are altogether against it, and, as another geologist has pointed out, it is probable that there would be no land surface to the globe if such were the case. A very small proportion of water in the melts seems fully competent to explain the known facts and, as I pointed out in introducing the paper, if one took the molecular weights of the substances into consideration, a very small percentage of water in the melts is sufficient to account for the difference in crystallization between gabbro and basalt as regards the mode of occurrence of their iron oxides.—W.H.G.].

* * * *

Dr. J. Vincent Elsden endorsed the remarks of previous speakers with regard to the incompleteness of our knowledge of some of the facts which appeared to be assumed in the paper. He referred more particularly to the high-temperature and low-temperature forms of calcic oxide and the proof, or evidence, that pyroxene lime differed from felspar lime. A positive proof of that problem would be very difficult to supply.

As geologists they had always been more or less in a state of perplexity as to the actual condition of what might be called a silicate melt. Many of them had expressed various opinions upon that subject. Supposing one took an olivine crystal and melted it, what was there in the melt? Was it olivine? Was it a mixture of magnesia and silica or was it still further dissociated, as probably would be found to be the fact, into more elementary substances still? The experiments which had been made as to the electrical conductivity in silicate melts seemed to prove that there was a progressive dissociation as the temperature rose; there was an increase of conductivity certainly, and that could be most reasonably explained by dissociation. Therefore, it might be expected that at a very high temperature one would have in the olivine melt, magnesium, oxygen, silicon, and perhaps various ions, according to the temperature, which would make up the whole thing, and, on cooling again, of course, would recombine to form the original olivine. That was probably the state of things in an actual melt, but when one came to the changes of volume which they had been hearing about that evening, these must be the result of cooling and crystallization.

One point which he had found somewhat difficult had been to reconcile Mr. Goodchild's theory with regard to those volume changes with some of the primary fundamental laws which he laid down as governing those conditions. For instance, they all firmly believed in the principle of Le Chatelier and the principle of Van 't Hoff, but he found it difficult to understand how those principles were satisfied by such things as an isothermal reaction in which expansion took place. That seemed to be a difficulty, but probably the author could explain it.

Then the author had referred in several places in the paper to reactions which were exothermic and expansive. He would almost have thought that an exothermic change could not be expansive; it seemed to him that such a change must be endothermic. That was so fundamental to the author's theory that the speaker felt he had either misapprehended some portion of it or that he had missed some point upon which he could probably be enlightened.

Again, with regard to one of the points upon which the author's theory seemed to rest, that is, the order of consolidation, Rosenbusch's normal order, it had to be remembered that, although that order might be called normal, it was not by any means universal. Let them take, for instance, the pyroxene crystal swarm described by the author; he expected that, if one examined the pyroxene-bearing rocks all over the world, quite as many cases would be found in which there could not have been a pyroxene swarm as those in which there might have been one. There was no pyroxene swarm in the ophitic diabase, or ophitic dolerites; in these, felspar crystallized first and formed the basis on which the pyroxene had crystallized afterwards. In regard to the normal order of crystallization or consolidation they had to bear those things in mind and consider them in their proper light.

Another point which had occurred to him was that the mechanism which the author described as explaining the squirting of, say, the metalliferous veins with liquid material, as far as he could gather, was due to the expansion produced by high volume changes in mineral composition, which exerted a pressure upon the residual fluid in the magma. If they were to believe in the normal order of consolidation that residual fluid should not contain very much mineral ore, because of all the substances which were deposited in the early stage he thought the mineral ores preserved the rule most generally. If that were so, the squirt of residual liquid would not have any metal in it, as practically it would have had its metal already precipitated.

[Dr. Elsden endorses the remarks of some previous speakers with regard to the incompleteness of our knowledge of some of the facts which appeared to be assumed in the paper. Now I particularly stated in the introduction to this paper that these facts, to which he specifically refers later in his remarks, were given in my original articles. He refers more particularly to the high-temperature and low-temperature forms of lime. This seemed to have been a stumbling-block to so many, but the physico-chemical evidence in regard to lime is remarkably clear and definite. Two forms of widely different densities have been actually prepared experimentally, and by means of density analysis of felspars and pyroxenes taken in conjunction with the question of affinity pressures, very striking and convincing evidence has been obtained of the relationships that subsist between felspar calcium silicate and pyroxene calcium silicate. In the case of aluminium silicate there are no less than three different silicates definitely known in the free state, but in the case of the calcium silicates they occur as double silicates intermixed with some other silicate, such as one of these aluminium silicates, so that the phenomena are not quite so obvious, but nevertheless density analysis on the lines I have developed brings them out into sharp relief and in an unmistakable fashion.

As regards Dr. Elsden's difficulty about an isothermal reaction accompanied by expansion, it is a question of ascertained fact and not one of conjecture.

The oxidation of ferrous oxide, which is a strong base that exercises a strong affinity pressure on silica, to ferric oxide is approximately isothermal, while ferric oxide is acidic and does not exercise this strong affinity pressure on silica, consequently the silica expands. Since Van 't Hoff's general theorem was that reactions proceeding at high temperatures tend to be endothermic while those at low temperatures tend to be of the opposite nature, an approximately isothermal reaction is precisely the sort of thing to be expected and looked for as likely to occur over an intermediate temperature range. As regards these exothermic and expansive reactions generally, I would refer Dr. Elsden to the experimental data given in my original articles.

Dr. Elsden's reference to the Rosenbusch law and its reversals is a welcome and penetrating contribution to the discussion. It is a matter of fundamental importance to any petrogenic theory. When one comes to consider these reversals in the light of the Le Chatelier law and the facts of allotropy, the meaning of it becomes pretty clear. It appears that the Rosenbusch order represents only one side of a reversible process, much like one side of a reversible equation. If the concentration of the low-temperature forms in a rock melt tend to become high, then in terms of the Le Chatelier law one would expect these to crystallize out before the unconverted allotropes, for when once conversion has taken place they are useless for the further generation of heat. By reversing the order in this way in the case of such magmas, the unconverted residues are available for a still further prolongation of the liquid state by their gradual conversion coincident with the continuous crystallization of the low-temperature forms and the consequent increase of water concentration in the residual fluid material.

As regards Dr. Elsden's remarks on the behaviour of the mineral substances, I would emphasize that there are two opposing factors that must be clearly borne in mind when dealing with the behaviour of these traces in a rock melt, and if these two opposing factors are not duly allowed for, one is apt to get in a hopeless muddle in trying to decipher their joint results. Cooling of the silicate melt down to the point at which crystallization just commences tends to precipitate these traces, but with the advance of crystallization of the main melt, the water concentration in the residua is continually increasing and this not merely tends to retard any further separation of ore-making precipitates but to drive early formed precipitates back into solution, so that, granted early precipitation of these ore-forming constituents, unless they become concentrated into large masses during the fluid life of the main magma by gravitative descent or in other ways, the scattered traces tend to redissolve in the final aqueous residua and become expelled in solution when the solidified crusts are subjected to those intense mechanical stresses developed during the later stages of magma consolidation.—W.H.G.].

THE MINERALS OF ANATOLIA

By NORMAN M. PENZER, B.A., F.G.S.

The author gives particulars of the mineral deposits of part of Asiatic Turkey, about which little is known in this country, though the Germans compiled records some years ago.

(Continued from August issue, page 81.)

COAL.—The coal deposits of Anatolia are of great economic importance, the pre-war output and value being far larger than all the other minerals put together. In the following notes reference is made to a map in this issue, and to the general map published last month.

Practically all the coal is mined in the vilayet of Castamuni in the Hereclea basin. The term "Hereclea basin" is used to denote all the deposits in the vicinity, that is to say, those of Kiosse-Aghzy, Zunguldak, and Amasra. All the deposits are situated near the Black Sea coast, the distance from Hereclea (often called Eregli in maps) to Amasra being 65 miles. At present the deposits are not known to stretch more than about 5 miles inland, although it is thought that beds connected with the most easterly of the deposits may be encountered further inland.

The three deposits above referred to consist of long and narrow parallel bands of Carboniferous rocks, comprising culm, lower Carboniferous limestones, and upper Carboniferous coal-measures. The general trend of the bands is N. 70° E. The correlation of the complete geological sequence of this area with the cretaceous of the Balkan has been established. The strata of the Hereclea basin can be classified in ascending order as follows:

(1) Basal Carboniferous limestone.
(2) Coal-bearing measures on which lie uncomformably thick Cretaceous beds represented by
(3) Greyish crystalline limestone.
(4) A mixture of dark clays and sandstone, for the most part fine-grained.

Palæontological study by M.M. Zeiller, Ralli, and others, has lead to a recognized local sub-division into three stages, the Aladja-Aghzy at the base, which comprises coal richest in volatile matter, the Cozloo or middle stage from which the best coal is derived, and the Caradon or upper stage containing a poorer variety of coal.

Beginning at the west end of the basin about 6 miles east of Hereclea at Kiosse-Aghzy, there occurs a long fault where the measures have sunk in depth. The coal seams in this district can be correlated with the Cozloo stage. The systems of seams occur here known as the Tsamly and Beylik groups. The former is the most important and stretches over a distance of about 2½ miles. At the village of Tsamly on the coast the seams appear nearly vertical.

Going eastwards the Aladja-Aghzy stage is best represented at the village of the same name. The strata have a general east-west strike and dip from 10° to 30° south. The region has undergone much faulting since the coal was formed, and there are 15 seams distinguished by various names. The same measures also appear at Kiosse-Aghzy and in the valley of the Kiretchlik. Almost vertical seams occurring along a double east-west line of faulting mark the transition zone between the Aladja-Aghzy and Cozloo measures.

The Cozloo stage is represented in the valleys of Zunguldak, Kilimli, and Chatal-Aghzy. This forms the most important part of the entire district. The strata dip respectively to the north and south, forming an anticline plainly visible in the Kilimli valley. In the Zunguldak valley the seams are 3 miles wide and extend some way beyond Chatal-Aghzy. Their average thickness is 4 ft. 9 in. Twenty-five seams are distinguished locally, but lack of geological information makes detailed information impossible. It was, however, reported in 1918 that a cadastral survey of the mines at Hereclea and Eski-Shehr was to be shortly undertaken.

The Caradon is represented at Cozloo and at the village of the same name between Kilimli and Chatal-Aghzy, but more inland than either. The seams have an average thickness of about 4 ft. Beds of clay are intercalated between the seams. The Amasra basin comprising the Chatal-Aghzy district also appears to form part of the same series. Five seams are known here. The outcrops east of Amasra are thought to be a continuation of this group.

The coal of the Hereclea basin is of the bituminous variety, and is lighter in ash than corresponding European types. It has been divided into two classes: (1) That obtained from the veins of the middle series, containing from 30% to 40% volatile matter; (2) that mined from the lowest stage, containing from 40% to 45% volatile matter. The first is excellent for coking purposes, while that of Aladja-Aghzy is used chiefly in the manufacture of illuminating gas and for steam generation.

Attention was first drawn to the Hereclean coalfield in 1854 during the Crimean War, when the Turkish Government allowed the allies to take what coal they liked. No further mining was done until 1885, when a French syndicate obtained a concession to work all the seams east of Cozloo, and to build a harbour at Zunguldak, and also to lay down a railway by means of tunnels from the mines to the coast. Seven years later the syndicate failed through want of capital, as did also a second French syndicate a year or two later. However, in May, 1896, a company was formed, known as the Société Français d'Héraclée. This company obtained a concession for 50 years to expire in 1946. It got the right to work all the mines, which constituted a group of nineteen seams varying in thickness from $3\frac{1}{4}$ ft. to $23\frac{1}{2}$ ft. The area was 5,000 hectares. Besides the mines above mentioned, which were worked by adit, one was worked by a vertical shaft over 800 ft. deep. The company also obtained permission to construct a port and quays at Zunguldak, the right to administer the same, and to join the mines to the port by light railways. The company built three cargo piers to facilitate the loading of the coal.

Difficulties were always cropping up when there was apparently no need for them at all. First of all the difficulties raised by the Government were of a purely technical nature, but in course of time they became legal and diplomatic. There were other troubles to contend with. Eighteen hundred miners were employed and a thousand workmen, but labour was always difficult because the native population is agricultural and the miners only work for short periods. They bring their own food and as soon as it runs out they go back home. The first appearance of snow also sends them

MAP OF THE HERECLEA COAL DISTRICT.

home. The Government did nothing to help the various companies which obtained concessions a few years later, but, on the contrary, seemed to find pleasure in breeding hostility between them.

With all these difficulties the Société Français d'Héraclée could do little with its capital of 10 million francs, and so great were expenses that in 1900 it had to borrow another 17,500,000 francs, and up to 1911 paid no dividend. Although the output was fairly good (1904, 456,075 tons; 1905, 403,033; 1906, 450,425; 1907, 484,807) no profit was made until some years later. In 1911, 1912, and 1913 matters had improved.

The following table shows the amount of coal sold at the port in these years, and the amount exported:

	1911	1912	1913
Bunker Coal	260,000	217 672	166,570
Exports to:			
Constantinople	60,000	186,415	160,585
Salonica	20,000	17,254	2,311
Smyrna	72,000	64,445	56,720
Roumania, Bulgaria, etc	60,000	28,113	39,717
Total amount screened and washed	472,000	513,899	425,903
Average price per ton f.o.b.	12s. 6d.	16s.	20s.

Several other concessions, already referred to, were also obtained. Les Houillères de la Banque de Métélin started very well, reaching an output of 90,000 tons, but owing to a bad fire the figures fell considerably. Another company, Les Houillères Rombaki et Panopulos, produced about 100,000 tons which it sold to La Société Français d'Héraclée. A fourth company, Les Houillères Saridja, produced 80,000 tons, but at a loss. The total production of these three companies in 1911, 1912, and 1913 was as follows:

Year	Tons	Price
1911	250,000	6s. to 7s f.o.b. chiefly to Turkey.
1912	220,000	12s. 6d. f.o.b.
1913	400,000	15s. 6d. f.o.b.

In 1913 the producing centres were as follows:

	Tons
Zunguldak	43,000
Amasra	6,000
Cozloo	177,000
Chatal-Aghzy	1,000
Kilimli	98,000
Aladja-Aghzy	7,000
Candilli & Tsamly	68,000

As has been already stated, there were many influences at work detrimental to the thorough and harmonious exploitation of the Hereclean basin, but one not yet mentioned was the dividing up of the area into too small concessions, which were too easily obtained. This trouble only disappeared when several of the smaller companies amalgamated into one or two larger ones, and it was found possible to bear the large initial expenses.

A few years before the war a German company under the control of Hugo Stinnes and the Deutsche Bank bought up a number of mines in this district, the chief of which was the Abadgi, from which 1,500 to 2,000 tons was extracted monthly. The Candilli mines were being opened out in 1917 by Hugo Stinnes with new shafts, as the old ones, being on the sea shore, were too exposed to gun fire. A Belgian syndicate was also formed, and the Germans bought up 5 million marks worth of shares. In 1916 these mines were taken over entirely by Stinnes and the Deutsche Bank.

For a long time the Germans have had a plan of connecting the Hereclea Basin to Bolu by rail. Bolu is situated on the Anatolian Railway near Adabzar.

The Porte recently bought the harbour of Zunduldak from the French company for nearly £600,000, as since the war the Turkish Government had taken over the control of the whole enterprise and had replaced the French employees by Turks and Germans. A further £90,000 was granted for the enlargement of the harbour, &c.

The Government is endeavouring to form all the different companies in the Hereclean district into a single large company for the exploitation of the district. In order to attain this end, it has ordered that the export of coal may take place only by way of Zunguldak, and the transport overland only by the railway now being built for the Government.

It was reported in the foreign press in 1918 that the "Société Français de Héraclée," which had been transformed into an Ottoman company, had 40% of the shares in the hands of the "Committee of Union and Progress," and 20% in the hands of the Ottoman merchants and shipowners. It will be interesting to see what finally happens in this area now that peace is signed.

The annual production of the entire basin in 1884 was only 70,997 metric tons; by 1900 it had gradually risen to 390,428; in 1911 it was 750,000; and in 1912 there was a slight drop to 700,000 tons. If the war had not occured it was thought that the output would soon have reached 1,000,000 tons. As to future developments little can be expected until a far more detailed geological and topographical survey is made and maps constructed. These will in all probability show hopeful possibilities in the Amasra-Djide region at the extreme east of the basin.

Apart from the Hereclean basin the coal deposits of Anatolia are unimportant. In most cases they only yield sufficient for local needs, as in the case of the deposits at Manjilik, south of Biga, Sokia, south of Smyrna, and Nazilli, east of Aidin. Other deposits have not yet been worked, as, for instance, the Lapsaki deposit near the Dardanelles.

By paying a certain percentage to the Government, the local inhabitants of Soma, north of Smyrna, draw coal enough to supply the factories of Soma, Kirchagach, Kereh, and Bergoma. It is reported from Konia that coalfields have been discovered in Jarik-Kasa, the development of which is being undertaken by the local authorities.

At Makri, in the south-west corner of the vilayet of Aidin, there is a coal mine which produces good quality coal. In the vilayet of Sivas, coal has been found near Zara, Zile, and Kardashlar. The deposits have, however, been very little worked.

LIGNITE.—Most of the lignite deposits belong to a transition stage between the Miocene and Pliocene, and are lacustrine in origin, the decaying vegetation having accumulated during a period of depression. The chief of these deposits is at Manjilik in the vilayet of Brusa. The seams outcrop for $2\frac{1}{2}$ miles, and are worked by the owners of the Balia lead mines near by. The lignite is used for an electric power-station, which feeds the smelters, &c. A small trade is done at the port of Akchai, where lignite is transported from deposits near Edremid. In Bigha lignite has been found at Lapsaki, but up to 1914 had not been exploited. The beds can be traced across the Marmora to the European coasts. There are also mines south-east of Panderma, between Kirmasti and Michalij. The quantity and quality of the lignite is small. Further east at Demirtash, 5 miles north of Brusa, deposits are also known to occur, but they are of no real importance. On the sea of Marmora at Gemlik two distinct formations are found, but they are of little value. Another deposit is at Koure, between Bilejik and Eskishehr, just east of the Anatolian Railway. By 1913 there was one shaft which had been sunk about 200 ft. Deposits have also been discovered at Gueve, between Brusa and Hereclea.

The most westerly Tertiary lignite is found in the mountains round Chai, near Afium Karahissar. Seams have been discovered here at an altitude of 1,840 metres, lying over calcareous conglomerates and capped by clay beds. The thickness of the coal attains 6 ft.

In the vilayet of Aidin there are three localities where lignite is found: Soma, Sokia, and Nazilli. The Soma deposits are situated 58 miles north-east of Smyrna. They were not worked previous to the war. The quality is decidedly second rate and it could only be used if mixed with better lignite or coal. The lignite was previously carried from the mines to the station by carts, but by 1917 an overhead railway was completed capable of dealing with 1,000 tons per day.

The Sokia deposits lie 50 miles south-south-east of Smyrna. The monthly production is about 500 tons, but the quality is even poorer than that of Soma. It is, however, good enough for use of the railways, and the cloth and flour mills in Smyrna.

The Nazilli mines are situated near the station on the Aidin Railway. The quality is equal to that at Sokia, and is conveyed by road and then by rail to Smyrna and Aidin. About 200 tons are extracted daily. The chief deposits belonged to an American company, but were little worked during the war.

In the vilayet of Angora, lignite has recently been discovered at Karaly-Bala. The quality is good and has given rise to a belief of the existence of coal in the vicinity, although as far as is known no further investigations have been made.

(*To be continued*).

The South-Western Polytechnic Institute, Manresa Road, Chelsea, London, S.W., will re-open on September 22, for day and evening courses. The courses include lectures in physics, chemistry, mathematics, and practical instruction in the fully equipped laboratories of the Institute. The chemical and metallurgical departments are respectively under the charge of J. B. Coleman, A.R.C.S., F.I.C., F.C.S., and W. A. Naish, A.R.S.M., A.I.M.M.

The Meeting of the American Institute of Mining and Metallurgical Engineers, held in Chicago this month, promises to beat the record in many ways. No less than 145 different papers will be presented, and the social features include a smoker, a banquet, boat excursions on Lake Michigan, and trips to points of historical interest. Of considerable interest in the week's programme will be a symposium on bituminous coal of low sulphur content, the supply of which is rapidly becoming exhausted. Contributors to this symposium are planning a discussion of means of conservation, which is expected to develop results of vital importance to the country. The technical discussions include subjects relating to practically every metal known to the mining world. The central location of the meeting will probably make it the largest in the Institute's history. The membership of the Institute now totals 7,500.

FOUR YEARS AS A PRISONER OF WAR

By J. C. FARRANT.

(Continued from the August issue, page 94).

The Author continues his account of the treatment of English Prisoners of War by the Germans, describing conditions in Saxony.

January 4, 1917. Chemnitz, Saxony. Men leaving for kommandos were compelled to give up their English blankets, which were personal property. Bowls, cups, knives, and forks, which had been purchased from the German canteen, were also taken away. This high-handed robbery was reported, but with the usual result.

January 6. I swapped a jersey for 2 oz. of German tobacco.

January 11. Russell, of the R.B., was murdered in the guard-room on Borna kommando J 675-6. Russell, who had been reported by one of the guards, was taken into the guard-house when the party returned from work. He was never seen alive again, and he was buried two days later. No Englishman was allowed to see him, but a Russian, who placed him in the coffin, stated his arm was broken and his body was covered with wounds. The matter was reported, and an inquiry was held by the Germans, but we never heard the result. Sergeant-Major Hall, of the R.B., who was exchanged shortly after, reported the matter in Holland.

Men were returning from kommando almost daily, mostly from coal mines, with smashed fingers, strains, and ruptures.

The life at the coal mines was hell. Condemned mines at Oelsnitz had been reopened and British prisoners of war were compelled to go below. They worked absolutely naked. At first men wore their boots, but the sweat made this impossible, and soon every one went barefooted. There was a night shift and a day shift. The men slept in crowded quarters and had no recreation. Indeed, they were only too glad to turn in after a meal. The place was alive with fleas and bugs, and continued in this condition during the whole of the time our men were there. In eight months 65% of the original number were returned to lager as unfit for work, and a man had to be very bad before he was excused duty. No two Englishmen were allowed to work together. As a rule a gang consisted of three Germans and one Englishman. There were numerous cases of manhandling. Self-inflicted wounds were not infrequent; anything to get away from that hell on earth, Oelsnitz. The numbers of the mines to which our men were sent were I 32, I 34, and I 37.

January 17. Twenty British N.C.O.s left Chemnitz for Holland. Urgent requests were made, by men who had been sent back from the mines as unfit, that a report should be laid before the Dutch Ambassador concerning the brutal treatment our men were receiving at the coal mines.

March 13. The Dutch Ambassador's representative arrived in the lager and many complaints were lodged. He departed for the coal mines next day. The usual farce was enacted at the lager the day upon which the representative arrived. Potatoes were placed in the cookers and left there. Firewood and coal were placed in conspicuous heaps in the drumming-up shed, and the hot water was turned on for an hour. Needless to say, as soon as he left the lager the coal and wood were taken from the drumming-up shed by the authorities. But on this occasion we did get the potatoes in the soup, the only potatoes we drew in the soup during the year 1918. I do not mean to say that no potatoes were issued, because they were being taken down to the cook-house on certain days. But we never saw them. The Russian cooks used to take what they wanted, and then various German N.C.O.s and soldiers would come and take what they could. So the graft went on.

March 23. The big German offensive started. We obtained German newspapers daily, so during the next three weeks we had an anxious time. The Germans didn't lose a chance of rubbing it in. However, April 1 was a holiday, and we were busy making preparations for a sports fête. Men were running round the square in the evening, getting fit. This was the best means we could employ as an antidote to the news appearing in the German papers.

April 1. International sports were held throughout the day, and the whole affair was quite a success. There was a field behind the lager, which at first was opened on Sundays only, but after various letters had been addressed to the commandant and the Dutch Ambassador, the authorities opened the field daily for a few hours. None of the English staff was supposed to play until after 5 p.m., and the field was closed at 5.30 p.m. As was only to be expected, the members of the staff used to dodge out and have a kick.

This field was also used for punishment. Defaulters were drilled in squads, each man carrying an old German pack, filled with stones and weighing about 60 lb. Punishment drill lasted two hours, and consisted of running, halting, lying down, getting up, and running again. A German sergeant-major issued the commands. This same punishment was inflicted at the mines, and many a man collapsed under it. One German sergeant-major in particular "had it in" for the Britishers. He was called "Willie Woodbine" because he was thin and anæmic.

He used to inspect the barracks daily at 10 o'clock, and anyone in the room had to stand to attention while he made his survey. On one occasion he pushed one of our men because he was not standing properly to attention. Taylor, the man who was pushed, hauled off to plant him one, but was fortunately stopped by the man next to him. Taylor was sent to chink, and thence straight to the mines, where he had a rough time.

Shortly after we were brought to Chemnitz, an order was given out that all Germans above the rank of lance-corporal were to be saluted. This was the first time since we had been captured that such an order had been given, and every one jibbed. Quite a number got cells in consequence. Bill Partridge, a Cockney sergeant in the Royal Scots, was reported to the commandant for refusing to salute a German sergeant-major. The commandant swore at him and ordered him to salute; Bill refused point blank, and got seven days' cells.

Previous to this a boxing tournament had been arranged, and Sergeant Partridge versus Sergeant Wilkinson, of the The Buffs, was one of the fights. The boxing was held on Saturday night at 6 p.m. Bill's time was up at 6 p.m. the same day; at 7 o'clock he was in the ring, and after six good rounds beat his man, and the same German sergeant-major saw him do it.

Here, as at other camps, the interpreters were our worst enemies, and the doctor at this camp was one of the worst we had struck. He was a dark-bearded man, and his soubriquet was "black muzzle." The sick were classified by this man. 1A, the dreaded "classment" meant mines. All kinds of dodges were used to induce palpitation, and in some cases appeared to be successful, though not many. Two men, Grassick and Brown, had been on the coal mines and had been returned as unfit. They were both determined that they would not go back. On different occasions they both "chucked dummies," that is to say, pretended to have fits. Brown had his fit in the square when the doctor was making his visit. He was taken to hospital, examined, and tested, and put under observation for three weeks. The final result was that both men got cushy numbers in the lager, and kept them till we came home.

Every Sunday, football matches were arranged, and many excellent matches took place. We really forgot we were prisoners on these occasions, unless the ball went over the wires. Sometimes the German guards would throw it back, but more often not, and then the game would be held up until a Frenchman, who looked after the sheep grazing outside, came to our assistance.

We were really in poor condition, as was evidenced by the fact that if a piece of skin was knocked off the place became septic the same night. The same thing happened at work, owing to the lack of fresh meat and vegetables for nearly four years.

May 6. 500 new British prisoners of war arrived. These men had been captured in the big push. Their general physique was not equal to that of the 1914 men.

May 17. One of the R.N.D. men was sent back from the mines suffering from brain trouble. He was quite off his head. The poor devil would implore every one he met to stop him from being sent to the mines again.

Just at this time there was an epidemic of "flu" in the lager; most of the men got it, among them myself. Six weeks later another epidemic of "flu" broke out. This was much worse than the first, and out of 26 deaths among the British, 23 were old prisoners of war, clearly showing how our general health had been undermined during our long captivity.

The numbers of new prisoners of war at this camp were nearly equal to those of the old at this time.

Every Sunday night a kinema show was given by the Germans in the riding school at a charge of 20 pfennigs and 50 pfennigs per man. The place was packed every time, and there were some exciting scrimmages at the entrance. The rushes, as soon as the doors were open, became so bad that the Germans posted guards inside the building with fixed bayonets. After the kinema had been running for some time, the Germans had the bad taste to show photos of military achievements, winding up by producing Hindenburg's portrait. This was the last straw. The picture was greated with yells of derision, which continued until the light was switched on. The commandant issued an order the next day that if such behaviour was repeated the whole lager would be placed under punishment.

During 1918 continual rumours were running round the camp that all old prisoners of war would be exchanged. As a matter of fact we had lived on these rumours for about a year, and every time a batch of sick was sent for examination to Aachen, exchange stock boomed high, only to fall again when 50% of the sick returned a week later, having failed to pass the doctor.

The exchange of officers and N.C.O.s started at the beginning of 1918, and we never gave up hope that the men's turn would come. But it didn't, at least not until the armistice was signed. During the second epidemic of "flu" the boys called it "exchange fever."

Men were coming into lager almost daily from the mines in bad condition, among them another man who had gone off his head. He was subsequently sent to an insane asylum. He belonged to the R.F.A. He would wake up in the middle of the night with a yell that startled the whole barrack-room, mentioning many times the name of "Knock-out Brown," a German N.C.O. whose name was K——, one of the worst type of man-handling bullies we had met. He was reported and court-martialled, but never received any punishment as far as we knew.

During August the reports from the west front were very encouraging, and coupled with constant exchange buzzes had the effect of putting the men in a very excitable frame of mind. The health of the men both on kommando and in the lager was very poor. Our blood was in such a state that if the skin became broken, it would take weeks before it would heal.

(To be concluded).

NEWS LETTERS

MELBOURNE.

July 12.

Broken Hill.—The closing down of the mines owing to the strike has led to greater attention being given to the outlook at the mines as regards reserves, and to the possibility of finding extensions of the ore deposits, as already known. Some of the mines are coming to the end of their ore reserves, notably Block 10, Junction North, and the Proprietary. These companies are taking interests in properties north and south on the basis of the Marshall theory. The Junction North has the Pinnacles, the Mayflower, and the Allendale; the Proprietary is developing the Potosi; Block 10 has an interest in some of the southern leases. Little work is being done at present on these outside leases. Development is proceeding on some of the Marshall blocks, two more of which were floated into a company in Sydney recently. The wolfram claims are all idle, and there is no sign of the central treatment plant that was going to do so much.

The contract between the Junction Mining Co. and Amalgamated Zinc (De Bavay's) has, as already recorded, been cancelled. The Junction raised and crushed the ore and De Bavay's treated it, but the arrangement did not prove altogether satisfactory. The termination of this contract together with the strike caused a suspension of production at the mine, and the future working of the property is being considered by the new directorate. There was recently a change in the board, and the control of the company was moved from Sydney to Adelaide. W. G. Thomas, well-known in Adelaide financial circles, is the new chairman. With a view to assisting it in its future policy, the board engaged the services of C. G. Klug, the Australian manager for Bewick, Moreing and Co., who will report fully on the property. Developments have recently shown that the mine has a fair-sized ore reserve, and although the lead contents of the ore are not as high as in some of the other mines, this is off-set by the silver contents. Taking the last three years' production, the ore averages 12% lead, 9oz. silver, and 7½% zinc. Judging from the experience of the Junction in its prior dealings with the Sulphide Corporation (I quote the *Industrial Australian & Mining Standard*) better results were obtained by mixing the Junction ore, which has a hard gangue, with the more easily milled ore of the Central mine. The best policy, however, would be to amalgamate with an adjoining property such as the British or Junction North, particularly with the latter, which is admittedly in need of feed for its mill. The Junction property is in close proximity to the Junction North plant, and most of the Junction workings are closer to the Junction North main shaft than to the Junction main shaft. Under the present regime, the Junction has been well opened up, is thoroughly equipped, and is able to produce a good regular tonnage of ore. In earlier years the old stopes in the upper levels were filled with high-grade tailing, which, under modern methods, would well bear re-treatment by anyone with the requisite plant. To-day, too, it is possible to recover some of the high-grade ore for which this mine was famous 20 years ago, and which was left in the old crushed ground. New lodes have been opened up, too, at the 900 and 1,000 ft. levels, the latter being the lowest working level, though the main shaft is down to 1,136 ft. The ore at the lower levels is of average value.

TORONTO.

August 12.

COBALT.—The silver-mining industry here is completely at a stand-still, owing to a strike of the miners who, to the number of over 2,000, walked out on July 23, as they had been threatening to do for some weeks. Definite action was delayed from time to time in the hope that a settlement could be arrived at by the intervention of Hon. G. D. Robertson, Canadian Minister of Labour, who opened negotiations with the mine managers. These were unavailing, as the employers firmly adhered to the position they have maintained throughout, in refusing to deal with or recognize the miners' union. This is practically the only question in dispute, as, though some further claims are put forward by the men, these issues are so comparatively trifling that, were the matter of union recognition out of the way, they could be very easily disposed of. The reason assigned by the mine managers for their stand is that previous dealings with the Western Federation of Miners, with which the union is affiliated, have been unsatisfactory. The position taken by the miners, and endorsed by the Minister of Labour, is that during recent years the policy and leadership of the Western Federation have been materially altered, and that it is unreasonable to judge that organization by the conditions which prevailed ten years ago. Since the strike was declared all attempts to effect a settlement have proved futile. Many of the miners have left the camp, and the mines are filling with water. One effect of the strikes at Cobalt and Kirkland Lake has been to stimulate development at the newer camps and outlying districts, where many of the strikers have found work on new prospects.

The Nipissing during June mined ore of an estimated value of $357,474, and shipped bullion from Nipissing and customs ore of an estimated net value of $111,777. The shareholders of the Kerr Lake have ratified a by-law reducing the capitalization of the company from $3,000,000 to $2,400,000. The Foster mine is being dismantled and the mining plant transferred to a property owned by the lessees at Gowganda. The Peterson Lake is installing new machinery to treat ore formerly classed as waste. L. W. Ledyard has resigned his position as manager of the Beaver Consolidated and is succeeded by Harry Donaldson, of Madoc, Ontario.

PORCUPINE.—The labour situation in this camp continues satisfactory, the relations between the companies and their employees being harmonious since an agreement was arrived at under which some of the grievances complained of by the men will be removed. The Hollinger Consolidated is building a hospital and has purchased three stores, at which their employees will be able to buy goods at considerably lower prices than have hitherto obtained. The men will also receive half-pay during periods of illness. The number of men employed in the district is greater than ever before, the Hollinger having 2,000 on its pay-roll and the McIntyre about 400. The Hollinger is installing machinery which will increase the number of stamps from 160 to 200, and this, together with the ball-mill, will increase the milling capacity to 3,500 tons daily. The McIntyre has declared an interim dividend of 5%. The mill is treating about 600 tons daily, the ore averaging some $10 per ton. Lateral work at the 1,350 ft. level will shortly be started, this being the deepest working at Porcupine. The shareholders of the Davidson have authorized the reorganization of the company, which will be known as the Davidson Consolidated Gold Mines, Ltd., with a capitalization increased to $5,000,000. The new company acquires additional territory, increasing the area from 120 to 420 acres. Shareholders will receive a bonus of one share of Consolidated stock for every three shares in the original company, and after paying for the additional acreage the company will have 1,000,000 shares in the treasury and $125,000 cash. Of the treasury stock 500,000 shares will be sold at 75 cents each to provide funds for development on a large scale. A power transmission line is to be run from the Davidson to the North Davidson, which has shown up well under diamond-drilling. The Norwood has let a contract for 6,000 ft. of diamond-drilling. Very promising ore-bodies have been encountered in trenching and diamond-drilling on the Sovereign. A shaft is down 60 ft. on ore averaging $9 to the ton.

BOSTON CREEK.—This area is not affected by strikes, and mining operations are being carried on without interruption. There is much complaint among mining men against the inaction of the Provincial Government, which, while carrying out an extensive road-making programme in many parts of Northern Ontario, has failed to provide the promised improvements in transport facilities for the Boston Creek district. The Miller Independence is building an addition to its mill, and it is hoped to have the machinery installed before the cold weather sets in. Diamond-drilling on the O'Donald claims, which are under option to the Allied Gold Mines, shows encouraging results, one vein 28 in. wide cut at depth carrying upwards of $17 to the ton. Extensive exploration work has been done in Skead Township and some good finds are reported.

THE PAS, MANITOBA.—Rich finds of gold at Copper Lake, some 70 miles north of The Pas, have caused a rush of prospectors into that district. The genuineness of the discovery is confirmed by Dr. R. O. Wallace, Commissioner for Northern Manitoba, who has examined samples of the ore and declares that he has never seen gold specimens equal to them in richness. The vein is stated to be 4 ft. in width, of quartz and greenstone, carrying very coarse gold forming 50% of the quartz. Dr. Wallace states that it is almost impossible to break the quartz, owing to the tenacity with which the gold holds it together. Many claims in the neighbourhood have been staked.

BRUSSELS.

An official report has been issued giving details of the condition of various Belgian industries at the beginning of June. Thinking that your readers will be interested in the latest news as to the present position of the zinc, lead, silver, and other non-ferrous metallurgical works, I am sending you a translation of this section of the report. The metallurgical industries in question are located in the provinces of Liége, Limburg, and Antwerp.

First, with regard to the province of Liége. The Société de la Vieille-Montagne, which obtains its ore from its own mines situated abroad, has restarted four zinc furnaces at its Valentin-Cocq works at Hollogne-aux-Pierres and six at its works at Flône; others will be started soon. In May, smelting had not been started at the company's plant at Angleur, but work will be commenced at any moment when the necessary ore is received.

The establishments for the production of crude zinc of the Société de Lamine and of the Société Austro-Belge, in the region of Huy, are not working on account of lack of ore. The Société de la Nouvelle-Montagne has been able to obtain a supply of ore, though at a very high price, and limited in amount, whereby it has been possible to start two blocks of furnaces. The Société Dumont at Sclaigneaux has also been able to light two furnaces which the Germans had not destroyed. The zinc furnaces and roasting furnaces belonging to the Société Anonyme Metallurgique de Proyon at Trooz - Forêt, are closed completely for lack of ore. At the zinc works of Ougrée, production has not yet started. Repairs of accessory plant are being continued, but the reconstruction of the furnaces has not yet been commenced. The zinc works of Bleyberg remain at a standstill. The principal obstacles are the lack of supplies of ore, the high rates of transport, and the excessive cost of fuel. It is impossible to fix a time for the reopening of the works, but it is hoped that this will be accomplished during next winter. On the whole, the production of the zinc smelters of the province of Liége is very much reduced, and this industry cannot regain its previous activity as long as the supply of ore is uncertain.

The zinc and copper rolling mills of Chênée, the zinc rolling mills of Fraipont, Angleur, Proyon, and Tilff, proceed at a reduced output by reason of lack of raw materials and high prices; the crude zinc treated comes chiefly from England and America.

In the province of Limburg and Antwerp, the stoppage is complete at all the zinc works, and there is no reason to anticipate the early recommencement of the smelters. The furnace of the Boom (Antwerp) works have, furthermore, been damaged by the enemy. The Lommel (Limburg) works have been at a complete standstill since January 31, 1919. The last furnaces working at the Overpelt (Limburg) works were put out of commission at the beginning of May. The Rothem works, also in the province of Limburg, has remained closed since the beginning of the war.

To sum up, it may be said that the zinc industry in Belgium is greatly handicapped for the following reasons: (1) Considerable increase in cost of labour, (2) a similar great increase in cost of coal, (3) unfavourable rate of exchange, (4) high freight charges. As compared with 1914 the cost of coal used in these works is now three times as high and the cost of labour is double. The result is that the cost of treating one ton of ore has increased from 70 francs to over 200 francs. Under these conditions it is impossible to buy ore at the present price and make a profit in smelting. As already mentioned, the rollers of zinc are beginning to introduce into Belgium zinc of foreign origin, English and American.

The sulphuric acid industry, as far as it depends on the roasting of zinc ores, has been stopped in the province of Liége. With regard to the works in the northern provinces that depend on the zinc works, at the end of May three roasting furnaces were started at Lommel, feeding a system of lead chambers. These are treating blende ores for a Dutch company. With regard to the works of Baelen, owned by the Société de la Vieille-Montagne, this was partly demolished by the Germans. All the lead from the chambers and the platinum from the catalytic plant were taken away. Most of the furnaces and part of the lead chambers have been repaired, and it is hoped by the end of the year to be working at about 50% of the normal.

The province of Liége has only two lead works, that of the Société Dumont at Sclaigneaux and that of Bleyberg, near the frontier. The first one was completely destroyed by the Germans and the resumption of work is not yet in contemplation. Some of the employees are occupied in repairing what remains of the original installation. Work has been partly restarted at the lead works of Bleyberg on material and residues which were left by the Germans and lead slags bought in Belgium. It is impossible as yet to obtain ore from abroad. Operations will expand as it becomes possible to buy raw materials in sufficient quantities, but it must be remembered that these raw materials consist for the most part of by-products of zinc smelting.

The lead, silver, and copper industries are represented in the northern provinces by the desilverizing works at Hoboken, the Vieille-Montagne works at Baelen-sur-Nèthe, and the Overpelt works. In the province of Antwerp the important works of the German company "Usine de Desargentation de Hoboken" have just been handed over, through the sequestration of the said German company, to the Compagnie Industrielle d'Oelen. All their plant is in excellent condition. In May only one roasting furnace, a cupelling furnace, and a refining furnace for the treatment of black copper of the Union Minière du Katanga were running. The works could be put again into activity in all its departments and the resumption of work would be complete if it were possible to obtain the raw material such as lead for desilverizing, lead slag, galena concentrates, copper mattes, or sulphide ores of lead, copper, and silver. The German company used to treat ore from German West Aftica.

At Baelen-sur-Nethe, the lead works of the Société de la Vieille-Montagne has suffered less than the sulphuric acid works, the only things taken away being the electric motors. It is hoped to set these works partly going again in two or three months' time, in such a manner as to reach, by the end of 1919, half of the normal production; but it is difficult at the present time to obtain ore on suitable terms. The installation of the Overpelt works, devoted to the treatment of complex lead, silver, and arsenical ores and mattes, are also at a standstill for want of raw material; at the end of May only a small furnace used for the treatment of lead mattes was working. The Beersse works of the Compagnie Metallurgique de la Campine, which produced before the war a considerable amount of antimony and copper, have been completely at a standstill since the Germans left. Their plant and tools have been very much damaged, and to a great extent have been put out of use; all ores and other raw materials have disappeared, and, in addition, the company has not the capital necessary to repair the damage and obtain raw material. These raw materials consisted mostly of ore and regulus coming from China, some copper residues, and antimony slag.

To sum up, the future of the zinc, lead, silver, copper, and antimony metallurgical industries is far from being assured, the stoppage having been almost complete. Belgium owed her prosperity in this industry to her special economic conditions, that is, cheap coal and labour and low shipping rates. By modifying these conditions the war has greatly handicapped the future prosperity of Belgian industries, which are based upon the treatment of raw material of foreign origin.

CAMBORNE.

NON-FERROUS MINING COMMISSION.—On August 9, the Board of Trade appointed the following gentlemen as a Commission to "investigate and report upon the present condition and economic possibilities of Non-Ferrous Mining in the United Kingdom and to make recommendations as to such Government action as may be expedient in regard thereto": H. B. Betterton, M.P. (Chairman), Henry F. Collins, J. Harris, Dr. F. H. Hatch, Sir Lionel Phillips, Bart., R. Arthur Thomas, and James Wignall, M.P. Messrs. Thomas and Harris represent respectively the owners and workers in the tin-mining industry, Messrs. Collins and Wignall the owners and workers in the zinc and lead-mining industry; and the other members were nominated by the Government.

The chairman's qualifications for that post are of a doubtful order, for he appears to have little or no practical knowledge of mining affairs, while certainly the labour representatives will be out of their depth when technical matters are under consideration. All the members of the Commission other than the chairman are known, by declarations already made from time to time, to favour Government assistance for the industry, and on this point it can only be the form of assistance or subsidy on which there is likely to be any difference of opinion. For this reason alone we are sceptical of any practical result of the inquiry, and this view, evidently, is held by representatives of the zinc and lead mines, for Mr. Felix Wilson, of the Leadhills Mining Company, at a recent meeting, referring to the inquiry and existing conditions, said: "the reformation will have to come from within, not from without." Most of the evidence and facts relating, at any rate, to the tin-mining industry are already in the possession of the Board of Trade. We hold the view, already expressed publicly by Mr. C. A. Moreing, that those interested in the tin-mining industry must take steps to help themselves by means of reorganization and scientific investigation if the mines are to be kept going, and Mr. Moreing, by his recent activities referred to elsewhere in this letter, appears to be acting on that opinion. There can be no question that the industry is deserving of Government assistance on national grounds, as has repeatedly been urged in these columns. Moreover, non-ferrous mining in this country clearly meets each of the following tests laid down by the Prime Minister in his speech of August 18, when he outlined the Government's proposal to shield unstable key industries: "(1). Whether the industry was revealed to be essential for war or the maintenance of the country during the war. (2). Whether during the war it was discovered that the industry had been so neglected that there was an inadequate supply of goods produced in the industry for the purpose of equipping ourselves for the essential tasks of war. (3). Whether it was found necessary for the Government to take special steps to promote and foster that industry during the war. (4). Whether if that special Government support were withdrawn those industries could maintain themselves at a level of production which the war has shown to be essential to the national life." But in spite of this, tin-mining is not included in the list of key industries recently scheduled by the Board of Trade, and the niggardly way in which the department is interpreting the recent promise, made to the Joint Industrial Council, of lending money on the security of machinery, as witness the case of Wheal Kitty (which occasioned a spirited protest on the part of the Joint Industrial Council at its last meeting), is evidence of the views prevailing at Whitehall. No doubt the public pressure for economy is the ready excuse, but economy should be on sound lines, and it is obviously unsound to let the tin-mining industry be seriously injured for the want of a little financial assistance, pending the return of more normal conditions.

Centralization of plants and amalgamation of properties, so that operations may be conducted on a much larger scale, thus materially reducing working costs, is clearly one of the recommendations which it may reasonably be anticipated the Commission will make, and steps to that end are not unlikely to develop in the not far distant future. Such a policy is obviously much facilitated in the Mining Division by the fact that the Basset and Clifden mineral rights are now owned by Tehidy Minerals, Ltd.

Messrs. C. A. Moreing and Oliver Wethered have been appointed by the tin-mining interests to give evidence from the owners' standpoint, and no better selection could have been made. We hope, too, that Mr. C. V. Thomas, whose work for Cornish mining behind the scenes is not so generally recognized, will, in his able and forceful way, find an opportunity of submitting his views.

GRENVILLE.—The financial resources of the company being exhausted, the directors have decided on a scheme of reconstruction, which will involve each shareholder who decides to support the scheme in a liability of 3s. per share. The existing company has a nominal capital of £100,000, divided into 200,000 shares of 10s. each, and of this number, 180,000 are issued. The new company will be of the same nominal capital, but will be divided in shares of 5s. each, and for each 10s. share in the old company, two 5s. shares, 3s. 6d. paid up, will be issued. As the issue has been underwritten at a total cost of 2d. per share, the sum of £27,000 will be available, less £3,000 for underwriting, or £24,000 net. In our opinion, this sum is inadequate to meet the registration costs, pay the debts of the old company (the trade debts alone are estimated at £9,000), meet current losses, and carry out the proposed development work in the upper levels, apart from any exploration in the bottom of the mine or any of the many equipment improvements referred to in the reports of Messrs. Josiah Paull and Joseph Nile. These developments in the upper levels are alone estimated at £12,000, and we therefore fear that before the mine has had the further chance which its past record warrants, the capital will be exhausted and the faith of those now backing the venture seriously upset. We hope this expression of opinion will not be thought due to lack of good-will; on the contrary, we admire the courage and perseverance of the directors under most discouraging conditions, but they suffer—and have for years past—through lack of sound technical advice. It is true they have now consulted Mr. Paull on the condition of affairs at the mine, and, incidentally, his report is by no means optimistic, but he says nothing of the outlay involved, nor probably would he know the financial condition of the old company. He says: "Given pre-war conditions, or a post-war price for black tin in relative proportion to the rise that has taken place in materials and labour, or other factors arising to equal the same, as for example, largely increased tonnage of production or rise in the produce of the same, your mine is, in my opinion, well worthy of fresh capital being put into it, and its chances of again becoming a prosperous undertaking are quite good." We should be prepared to endorse this conditional expression of opinion if, before "fresh capital," the word "adequate" were inserted, and by "adequate" we mean at least £25,000 for expenditure in and at the mine alone.

It is quite evident from the reports referred to that no systematic sampling of the lodes has hitherto been carried out, nor any assay plans kept at the mine; the lack of this very necessary information may now lead to the waste of much money on clearing levels for investigation purposes. This is more evidence of the need of independent technical advice.

The development work already undertaken in the upper levels has given very encouraging results, and with the opening up of many points of attack, there is good reason to believe that large quantities of average grade ore will become available, sufficient, perhaps, to warrant an increased milling capacity. In the bottom, too, the management are hopeful that when the water is got out, it will be found that a bunch of rich tin ground is within sight at the 395 fm. level. It is interesting and comforting to note that Mr. Paull does not anticipate any trouble with the water from the adjoining Basset mine. He suggests the installation of an electrical pump at the 150 fm. level to supplement the existing pumps by dealing with the large influx of surface water; by this means, the pumping costs could be considerably reduced and the life of the Cornish pumps prolonged.

THE CLIFDEN DEAL.—In February last, we recorded in these columns the purchase of the Basset mineral rights by Tehidy Minerals, Ltd., a company with a nominal capital of £100,000, formed by the Dolcoath and East Pool groups, the purchase price being £60,000. Now we have to record a much more important transaction in the transference to the same company of the mineral rights of Viscount Clifden for a sum of £200,000, all of which, with the exception of £10,000, is payable in fully-paid shares of the company. To enable this to be done, the nominal capital of the company has been increased to £300,000. Of the 190,000 shares to be issued to Viscount Clifden, 40,000 are offered to existing shareholders—other than the Dolcoath or East Pool companies—at par, and as the shares command a premium, this is equivalent to a substantial bonus, and no doubt they will be readily absorbed. This will leave Viscount Clifden with 150,000 shares, or slightly more than half the capital of the company. This is surely showing substantial faith in its future.

The mineral rights acquired relate, in the aggregate, to over 25,000 acres, principally situated in Mid and West Cornwall. In West Cornwall, the mines which are being worked include Wheal Agar (leased to East Pool & Agar, Ltd., in which the famous Rogers lode is located) and Tincroft mines, while in the parish of Illogan, the areas acquired adjoin and fit in with the other setts already belonging to the company, so that, if, as seems likely in the future, large propositions are to be the order of the day, it will be very helpful to this end that the minerals will be under one ownership. In Mid Cornwall, the principal rights acquired are those for china clay, and taking pre-war output figures, say 70,000 tons per year, the pits concerned produced about one-eighth of the total output for Cornwall. But, in addition, there are large areas at present undeveloped or not even tested which it is believed by Mr. J. Gilbert will prove to be good clay ground. There can be no doubt that although at the present time production is more than equal to demand, when labour settles down once more and trade conditions can be more clearly estimated, the demand for clays for the Continent and America will be enormous, and, bearing in mind that the selling price is controlled from Cornwall, we firmly believe that there is a very bright future for the china-clay industry in this country. Mr. Gilbert asserted at the meeting that the output of clay in Cornwall had reached 1,000,000 tons by the end of 1913, but this was not so, and probably the error arose through the inclusion of the Devon output. As the figures given at the meeting by Mr. Moreing were only for 1912, we append some later figures extracted from the Year Book of the Cornish Chamber of Mines:

	Cornwall		Devon		Totals	
	Tons	Value	Tons	Value	Tons	Value
1913	862,977	£555.330	414,868	£170,097	1,277,845	£725,427
1914	803,576	539.512	353,018	150, 87	1,156,594	689,899
1915	549,670	361,272	222,254	96,395	771,924	457,667
1916	564,826	389 908	166,789	85,721	731,615	475,629
1917	439,661	342 536	143,074	99,012	582,735	441,548

The reduction of output indicated was due to the war.

Of course, the present available working capital of the company would be quite inadequate for the development of its properties, or one might even say for the testing of them, but there are strong groups behind who can find all the money required. It appears to be the settled policy of the company not to work the properties but to sell outright or grant leases, although, no doubt, a certain amount of exploratory work will be done. The company is at the present time in receipt of a revenue from royalties of approximately £20,000 per year, and it will doubtless aim to substantially increase this sum. It was a bold stroke on the part of Messrs. C. A. Moreing, C. V. Thomas, and Oliver Wethered to acquire the Clifden rights, and it is good evidence of the faith of these three leaders in the future of the Cornish mining industry.

GEEVOR.—The publication of the report made on this property by Mr. Josiah Paull, as a result of a recent inspection, is being looked forward to with interest, but it may with confidence be stated that it will be of a highly favourable nature. The developments continue to disclose high-grade ore, and every engineer who visits the property appears to be impressed with its great possibilities. The accounts, when issued, should show a fairly satisfactory state of affairs, but doubtless more capital will be needed if the milling capacity is to be yet again enlarged. A dividend may be expected to be declared by the time this letter is published.

EAST POOL & AGAR.—It is good news to hear that the water has at last been got out of the workings on the Rogers lode at the 240 fm. level; it has been a difficult and expensive task. Locally the slow progress in unwatering made a bad impression, and this doubtless accounts for the recent weakness of the shares. Now that the stopes on the 240 fm. level are available, and it must be remembered that the highest values were encountered at this level, it may reasonably be anticipated that the returns will considerably improve. With the installation of electric pumps to supplement the Cornish pump at Agar, there need be no fear in the future.

WAGES AND PRODUCTION.—The demand by the Unions for increased wages having been refused by the Owners' Federation, the Unions are now suggesting that the application should be submitted for arbitration. The owners, under the circumstances, will be well advised to refuse to go to arbitration; the best answer is that there are not more than two mines in Cornwall able to meet costs at the present time.

At the Joint Industrial Council, an interesting and illuminating discussion recently took place on the question of increased production, and the suggestions of the sub-committee of owners and workers to that end are awaited with interest. It has been truly said that on the average the miners do not put in $5\frac{1}{2}$ hours per shift at the face, and even when they do, the efficiency is so very poor. There can be no doubt in part this slackness is due to the fatal policy, much in vogue in the past, of cutting rates if the men did well, but there are now not many managers foolish enough to act so shortsightedly. But it is difficult to eradicate the conviction of the miner on this score, a conviction handed down from father to son.

ACQUISITION AND VALUATION OF LAND.—As a substitution for the state purchase of minerals, which it is urged would put an end to the alleged evil of recalcitrant owners who refuse to allow their minerals to be worked except on impossible terms, the Ministry of Reconstruction Committee dealing with this subject agreed that wherever any private right, proprietary or contractual, interfered with the national interests in connection with mineral development, there should be an independent authority over-riding such private rights on fair conpensation. This is a matter which the Commission of Inquiry will doubtless deal with.

RESEARCH WORK.—The report of the Tin and Tungsten Research Board for 1918-19 was published recently, but as reference has already been made to it in the Magazine I need not go into details here. I would like to say, however, that the investigations of the actual Research Committee are in the main directed to improvements on existing methods of extraction. It is left largely to outside investigators to experiment on entirely new lines, and certainly the view in Cornwall in many quarters, although not openly expressed, is that the work is not being pushed very energetically by the

Research Committee, nor conducted on right lines. However, when details of the results of the work done for the Research Committee by Messrs. O. J. Stannard, H. W. C. Annable, H. R. Beringer, A. M. Drummond, and F. H. Michell are published, a better idea will be obtained of the value of the mode of investigation.

Mr. Moreing has now made public the fact that extensive research work has been carried out at East Pool—quite apart from the now suspended tests on the Richards process—and laboratory results of the process, believed to be flotation, show an extraction of 93%, and a unit of plant for testing it on a commercial scale is now being erected. Mr. Moreing has high hopes of the success of this process, and if his optimism is justified, his firm, responsible for much splendid metallurgical work in other parts of the world, will be credited with the rejuvenation of Cornish mining.

TINCROFT.—This mine has recently been examined by Messrs. Bewick, Moreing & Co., proposals having been made for its acquisition by a neighbouring mining company, but no decision as to this is yet known locally. Doubtless considerable losses are still being made in spite of the improved prices for tin and arsenic, but we firmly believe that this mine would justify the expenditure of a considerable sum in development.

LEVANT.—The accounts for the 16 weeks ended August 23 last show a loss of £2,976, after deducting £2,300 expended on "reconstruction," or presumably in other words on work of a capital nature. The difficulty is that no capital account is kept by mines run on the cost-book system. The loss made compares with £3,237 lost on the previous 16 weeks' working. The following comparative figures will be of interest:

4 months ended	Tons of ore milled	Black Tin Production: Quantity tons	Average price £	Value £	lb. per ton milled
May 3, 1919	4,427	110·2	121	13,363	55
Aug. 23, 1919	5,368	116·7	136	1[illegible]908	49

NORTH OF ENGLAND.

The position is worse, but it is a little clearer. We know at least where and how we stand. It cannot be said that the prospect is at all cheerful. It is true that the Board of Trade has appointed a Commission to investigate and report upon the present condition and economic possibilities of non-ferrous mining in the United Kingdom, and to make recommendations as to such Government action as may be expedient in regard thereto, but it is doubtful whether we have much to hope for from the Government whatever representations may be made to them by the gentlemen who constitute the Commission. It is patent, however, that for the present we can only mark time. The gentlemen who compose the Commission are mostly well known to our industry. Mr. Henry F. Collins is of course the representative of the Lead & Zinc Association, Mr. James Wignall, M.P., is the representative of the Non-Ferrous Industrial Council; Mr. R. Arthur Thomas, is representative of the Cornwall tin mines; Sir Lionel Phillips is the late Controller of Mineral Resources; and Dr. F. H. Hatch, is the new Controller. Mr. H. B. Betterton, M.P., the Chairman of the Committee, and Dr. Hatch, I understand, are shortly to visit the North of England mines, and will afterwards try to make the round of the Welsh mines. The Lake Country mines, Nenthead and Weardale, are all, I believe, to come within the purview of Mr. Betterton and Dr. Hatch. It may not be without interest, by the way, to mention that though the Ministry of Munitions staff concerned with mineral resources is being disbanded, it is not unlikely that Mr. Cunningham will remain. If such proves to be the case we shall all be very pleased, for Mr. Cunningham knows the whole subject from top to bottom, and the capacity he has shown for the position he holds has won him the respect and confidence of all, and it should surely be unnecessary to add that his engaging personality has made him liked by every mine-owner who has come in contact with him.

Strong representations have been made by the Lead & Zinc Mine-Owners' Association with a view to the continuance of the output bonus until the report of the Commission has been received. So far nothing has been heard of what effect, if any, they have had upon the powers that be, but I believe that Dr. Hatch is doing his utmost to obtain the reconsideration of the subject. The bonus terminated on June 30. The industry has been two months without it, with the result that production has been suspended at Thornthwaite and at Nenthead, the latter a mine which raises about two-fifths of the entire output of the United Kingdom. Notice was given to the whole of the men to cease work on September 10, and any men who are retained after that date will continue their employment on three days' notice.

A strike has occurred at the Mill Close mine in Derbyshire, the Union having withdrawn the firemen, enginemen, and pumpmen. It is to be hoped that wiser counsels will prevail among the men, who appear to have acted with unusual precipitation, and that if they do not resume work they will at least permit the pumps to be kept going.

The production of lead and blende is being suspended at Force Crag in the Lake Country, and I believe that the company intends to concentrate its energies on barytes, of which it has a very fine deposit. As far as Threlkeld, not many miles away, is concerned, work is being practically confined to development. The owners have suspended the reconstruction of the dressing plant, pending the decision as to what their position will be regarding the output bonus. The forebreast on the main horse level is showing good ore, certainly two tons to the fathom, which with this easily worked lode is a paying proposition, subject to reasonable prices being obtained. The whole development of the Caldbeck area is now in abeyance, as the capitalists interested say that they cannot possibly touch it under the present circumstances.

One of the North of England managers offered his output of blende to one of the smelters and received an absolutely astounding reply. It appears that the smelters are not at liberty to purchase home-produced blende without a special permit from the Government. This question has been put to the Board of Trade, but no reply has been received. It seems fairly obvious that the Government is determined to place its concentrates, namely, those purchased from Australia, in preference to those of the home-produced ores. At all events, in this particular instance, as the smelter had no permit to buy the ore from this mine, the manager was unable to obtain an offer.

One of the chief smelters informs me that as a matter of fact smelting is a game not worth the candle in existing circumstances. If you are rolling sheets or making pipes you can calculate the cost if you buy lead from the Government. But he is not prepared to engage in any contract for the purchase of ores unless he safeguards himself against the possibility of a further rise in wages, and he can only cover by buying ores at a low figure. He has to discount the costs consequent upon shortening of hours of labour and the increase in the price of coal, and he has therefore to quote a price which is ridiculous. In this particular instance, in which the smelter represents the lead smelters generally, the prices offered work out at considerably below the pre-war figures for ores. A broker tells me that the cost of importing pig lead and spelter is about £10 per ton. When the Government has completed such obligations in America as it entered into for the purchase of lead and zinc, the price in England of American lead must be as far as America is concerned £10 above the American quoted price. But the tide has begun to turn. The Government stocks of lead were reduced during July, and it is probable that they were further decreased in August. It is reported that consumption is only at the rate of 64,000 tons per annum at the present moment. The pre-war home consumption of lead was 200,000 tons. If these figures are correct, the present stocks of lead will probably be absorbed within the next six months. Assuming that we shall return to the normal rate of consumption the feeling in well informed quarters is that lead must rise to well over £30 and probably as high as £35 per ton, and spelter to a figure approaching £50 per ton. The zinc smelters at the present time are of course well safeguarded, as the Government is purchasing the whole of their output at a fixed price of £56 per ton, a figure which represents a bonus of almost £18 per ton, paid out of the taxpayers' pockets. This arrangement may be terminated by the Government on November 5. The difference in the treatment of the producer of the raw material and the smelters is a subject that might very well call for caustic comment. The battle is to the strong. The smelters put a pistol to the head of the Government. Their threat to close down unless the guarantee was given was effective.

A contemporary makes the naive suggestion that as the Government has a great stock of concentrates on their hands they should be sold at a low price to the smelters, and thereby dispense with the continuance of a guaranteed price to the smelters, and so avoid the suspicion of giving a subsidy to any particular industry. I understand that Mr. Anthony Wilson, of the Thornthwaite mines, a gentleman with an unrivalled knowledge of the industry in which he is engaged, who exercises great influence among mine owners, has written to the editor pointing out how disastrous this would be to the home mines. If the Government adopts this policy of selling zinc ores at a nominal price in order to get rid of something for which it had not a sufficient sale, it would bring the price of all the blende from home producers to the same level. The uncertainty as to what the Government is going to do concerning these concentrates prevents any user of zinc ore from making definite contracts for purchase from the home mines. No wonder is it that in a recent instance a consumer of zinc ores (not a smelter) offered a very much lower sum (£2 a ton) than their ore is worth to him at the present moment.

PERSONAL

C. A. BANKS has returned to Canada.

E. G. BANKS, manager of the Waihi Gold Mining Co., is returning to New Zealand by way of Canada.

GUY BERLING has been appointed general manager in Australia and New Zealand for the Ingersoll-Rand Company.

R. E. BINNS is returning for Spain.

E. C. BLOOMFIELD has sailed for Burma

F. K. BORROW is here from the mines of the Frontino & Bolivia Company, in Colombia

G. A. BROWNE has left for Nigeria.

G. W. CAMPION is returning to Taquah, West Africa.

A. R. CANNING is returning from Nigeria.

H. F. COLLINS is back from Spain.

N. F. DARE has left for the Federated Malay States.

W. BOYD DAWKINS, Emeritus Professor of Geology in the University of Manchester, has been created a Knight.

H. S. DENNY, C.B.E., has been demobilized after four years of factory work and three months assisting General Plumer in Cologne. His address is Salisbury House, London, E.C.2.

W. ELSDON DEW is the new president of the South African Institution of Engineers.

SAMUEL EVANS is here from Johannesburg.

JAMES GRAY has been elected president of the Chemical, Metallurgical, & Mining Society of South Africa.

MAX HONNET has been appointed assistant general manager of the Central Mining & Investment Corporation.

J. A. B. HORSLEY has been appointed an electrical inspector of mines under the Coal and Metalliferous Mines Regulation Acts.

JAMES HOWLISON is in Abyssinia.

COLONEL H. W. LAKE has been released from military duties and is back in the City. His address is Broad Street Avenue, E.C.2.

ERNEST LEVY has left British Columbia for Havana, Cuba.

M. C. H. LITTLE has been appointed manager of the Aber-Llyn zinc mine, Bettws-y-Coed, North Wales.

H. E. NICHOLLS has left for Nigeria.

W. PELLEW-HARVEY has left for Spain.

Dr. J. E. PETAVEL, F.R.S., professor of engineering in the University of Manchester, has been appointed director of the National Physical Laboratory in succession to SIR R. T. GLAZEBROOK, who retires this month on reaching the age limit.

W. J. PHILLIPS has returned from the Raub gold mines, Pahang, and is now at Chacewater, Cornwall.

THOMAS T. READ, formerly associate editor of the *Mining and Scientific Press*, and lately with the New Jersey Zinc Co., has joined the staff of the United States Bureau of Mines.

J. B. RICHARDSON has left for Bolivia.

CAPTAIN W. R. RUMBOLD, M.C., of the firm of Laws, Rumbold & Co., writes from Nigeria saying he expects to be demobilized shortly and to be back in London in September.

W. E. SIMPSON is here from Canada on a short visit.

SIR HARRY ROSS SKINNER is expected from South Africa.

J. E. SPURR has been appointed editor of the *Engineering and Mining Journal*.

C. H. STEWART, of the firm of Alexander Hill & Stewart, is in Cuba.

W. F. WHITE is back from Felixstowe after a month's absence due to a sharp attack of pneumonia.

HALLETT WINMILL has left for the Gold Coast.

ARTHUR BURR, for so long identified with Kent coal, died last month. His methods of finance were erratic and unorthodox, and the new coalfield suffered in repute accordingly.

W. TOVOTE has been killed by Yaqui Indians in Chihuahua. He was a capable mining geologist, and knew the south-western States and northern Mexico well. His articles in recent issues of this Magazine were characteristic of his careful habit of observation.

FRANCIS WILLIAM OLDFIELD, who recently returned from Mexico to England owing to ill-health, died in London after a fortnight's illness. He represented the Marcus Daly mining interests in Mexico, of which Judge Gerrard, ex-Ambassador to Germany, is president. During the Mexican revolution he managed by his ability and tact to operate successfully one of the few mines running during this time in the south western part of Mexico, which now ranks among the foremost silver-producing mines in the world. His record in Cinco Minas speaks for itself, for during six years' stay under revolutionary conditions operations at the mine had been practically continuous and large profits had been made all at a cost lower than that of any other mine in the district. He took his A.R.S.M. in 1901, and was an Associate Member of the Institution of Mining and Metallurgy and a Member of the American Institute of Mining and Metallurgical Engineers.

TRADE PARAGRAPHS

THE CLARK TRUCTRACTOR COMPANY, of Chicago, has been recently incorporated for the purpose of making a motor which will carry a load and also haul trailers behind it. The machine has one wheel in front and two behind. It is built entirely of metal, its centre of gravity is low, and it can turn in its own length. Many applications can be found for it at the mine and metallurgical works.

THE STANDARD SPIRAL PIPE WORKS, of Chicago, U.S.A., send us a catalogue relating to their reinforced spiral steel pipes. These have a continuous interlocking seam, with the rib which acts as a reinforcement outside, the inside being quite smooth. They are useful for many purposes in connection with mining, for water or oil, steam, or compressed air, powdered-coal circulation, pump-dredging, chimney stacks, etc. The catalogue gives full details of dimensions, and of joints and other accessories.

EDGAR ALLEN & CO., LTD., of the Imperial Steel Works, Sheffield, have commenced the publication of the *Edgar Allen News*, a house organ devoted particularly to the interests of their business, but containing also a great deal of useful information relating to steel and its applications. The tool steel and the ore-crushing machinery made by this firm are well known in mining circles. Engineers are recommended to apply to the firm for a copy of the *News* to be sent to them regularly.

HENRY GARDNER, for so long a director of Henry R. Merton & Co., Ltd., having obtained a licence to trade under the Non-Ferrous Metals Act, has formed his business into a limited liability company, under the name of Henry Gardner & Co., Ltd., with a capital of £1,000,000, of which £650,000 has been issued and fully subscribed. The directors of the new company are: Henry Gardner (chairman), Walter Gardner, Sir Woodman Kirby, George E. Leon, and William Murray. The new firm has purchased the whole of the share capital of HUNTINGTON, HEBERLEIN & CO., LTD., mechanical, chemical, and metallurgical engineers. The board of the last named company will consist of Walter Gardner (chairman and managing director), H. C. Bingham, H. J. Bush, and R. H. Bingham.

THE BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO., LIMITED, of Trafford Park, Manchester, have sent us the following pamphlets relating to new specialties: Industrial motor drive of planing machines; large outdoor switches and transformers; bracket pedestal bearings; some Westinghouse electric winding engines; direct current motor starters, type "SD"; Westinghouse motor generators; British Westinghouse oil-immersed forced cooled single and 3-phase shell and core-type transformer; British Westinghouse single-phase shell type oil-immersed self cooled transformers. The particulars of the winding engines are of special interest; fuller details will be sent by the company on receipt of a request.

HADFIELDS, LIMITED, of Sheffield, have issued catalogue No. 147, giving up-to-date information of breakers, rolls, and disc crushers. The wearing parts are, as is well known, made of Hadfield's "Era" manganese steel. The machines illustrated in the catalogue are intended for handling ore on a large scale. The breaker, of the jaw type, has a feed opening 54 in. long by 36 in. wide. It will take a block of ore or stone weighing 1½ tons or more and reduce it to 6 in. or 8 in. pieces. The capacity is about 150 tons per hour, and the power required is from 150 to 200 h.p. The weight of the machine is 90 tons. The high-speed rolls illustrated are 60 in. diameter by 42 in. wide. They will crush Lincolnshire ironstone as delivered by the steam-shovel to 6 in. or 8 in. pieces at the rate of 100 tons per hour. They revolve at 200 r.p.m. and require 100 to 150 h.p. One of the rolls is fitted with two rows of slugger-teeth for breaking up the larger pieces. The catalogue also illustrates the Symons disc crushers. These are essentially large capacity breakers, taking the ore from the sledging crushers and reducing it to 2½ in. or less.

THE DORR COMPANY, of New York and Denver (London office, 16, South Street, E.C.2), have issued Bulletin 13 describing the Dorrco pump, which is of the diaphragm type, and is intended primarily for regulating the consistency of the discharge from Dorr thickeners, though it is also applicable to elevating sludge where the actual lift is not greater than 6 to 8 ft. The pump body is mounted on suitable base boards rigidly bolted to a steel and iron frame. The upper part of the frame supports the eccentric shaft on which the drive pulleys and eccentrics are mounted. The eccentrics are adjustable by means of a hand screw to give a variation in length of stroke. The eccentric is connected through an eccentric rod and lift yoke to the centre of a flexible diaphragm in the pump body. A light hood is supplied to cover the top of the pump body and prevent splash. The body of the pump is divided into an upper and lower chamber by means of a diaphragm. The diaphragm is clamped rigidly around its periphery to the pump body by means of a retaining ring, which can readily be removed when it becomes necessary to renew the diaphragm. The lift yoke containing the discharge valve is attached around the central opening in the diaphragm. The lower or suction chamber contains the suction valve operating immediately over the feed or suction line to the pump. The upper or discharge chamber is open and is provided with a discharge lip which is from 4 to 6 in. above the discharge valve. This depth of pulp protects the valve from air in case it is prevented from seating properly by foreign matter such as chips, waste, etc. Both valves are opened by the action of the diaphragm and are closed by gravity, no springs being required. They are retained in place by suitable guide webs. The valves are faced with rubber gaskets which seat on rubber rings wedged into replaceable metal valve seats. The upper valve is larger than the lower, and both valves may be easily removed without dismantling the pump by lifting the lower valve through the upper valve opening. This type of valve quickly cleans itself from chips and waste which frequently interfere with the operation of other types of valves. Among the many advantages claimed for the Dorrco over other diaphragm pumps are: (1) Integral casting for pump base and bowl; (2) novel method of securing the diaphragm; (3) novel design of valves and valve seats; (4) high discharge lip. At the bottom of the suction chamber and level with the suction valve a small hole is tapped for the admission of water tangentially to the periphery of the valve. With pulps containing appreciable quantities of coarse material the water is useful in freeing the valve in starting up after a shutdown. Another small hole is tapped in the upper part of the suction chamber for the admission of air for controlling the capacity of the pump. The capacity of the pump is regulated by means of the speed, length of stroke, and by the admission of air to the suction chamber. Ordinarily the speed is held constant and the eccentric adjusted to a slightly greater stroke than required. The final control is then obtained by means of a small quantity of air admitted to the suction chamber through a needle valve. A ¼ in. pipe is connected to the suction chamber and extended 2 or 3 ft. above the top of the pump body, terminating in the needle valve. The valve is thus removed from any danger of contact with the pulp. The admission of air provides a very delicate and satisfactory means for accomplishing a close regulation of the quantity pumped. This equipment is furnished with each pump. As compared to an air lift or free spigot discharge, the Dorrco pump is much more efficient in maintaining a uniform discharge from thickeners at a maximum density. The operation of the pump is extremely simple and requires practically no attention except lubrication once a shift, unless it is necessary to change the capacity of the pump. The power required is very low and for a simplex No. 4 pump will usually be about ½ h.p. The power for a multiple pump is less in proportion than for a simplex, since the eccentrics are set at equal angular distances around the shaft, thus giving a balancing effect. At one plant a No. 4 simplex required ½ horse power motor input when lifting 140 tons of solids per 23 hours at 40% moisture a distance of 2 ft. above the top of the thickener tank. In erecting the pump it is important to properly adjust the length of the eccentric rod to prevent over-stretching and tearing the diaphragm on either the upward or downward stroke. The natural shape of the diaphragm as installed in the pump represents approximately its maximum downward position. With the eccentric set for the maximum downward stroke, the eccentric rod should be connected to the lift yoke with the diaphragm at rest in its natural position. When handling cold neutral sludges diaphragms should last from three to four months, and there are numerous records showing lengths of life exceeding a year. The firm have developed diaphragms of special construction for general use as well as for strongly alkaline, acid, or hot sludges. In these diaphragms none of the fabric comes into contact with the sludge. Special moulds are used so that rubber covers the fabric throughout the surface as well as inside of the bolt holes and valve opening.

DAILY LONDON METAL PRICES: OFFICIAL CLOSING PRICES ON
Copper, Lead, Zinc, and Tin per Long Tons; Silver

	Silver	Copper				Lead
		Standard Cash	Standard (3 mos.)	Electrolytic	Best Selected	Soft Foreign
Aug.	d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
11	58½	91 2 6 to 91 7 6	92 2 6 to 92 7 6	104 0 0 to 115 0 0	106 0 0 to 107 0 0	24 7 6 to 25 2 6
12	58⅝	92 5 0 to 92 10 0	93 5 0 to 93 10 0	103 0 0 to 114 0 0	105 0 0 to 106 0 0	24 12 6 to 25 7 6
13	58⅝	96 0 0 to 96 5 0	97 0 0 to 97 5 0	103 0 0 to 114 0 0	105 0 0 to 106 0 0	24 15 6 to 25 15 0
14	58⅞	97 10 0 to 98 0 0	98 10 0 to 99 0 0	103 0 0 to 113 0 0	105 0 0 to 106 0 0	25 2 6 to 25 12 6
15	59	98 5 0 to 98 10 0	99 5 0 to 99 10 0	105 0 0 to 114 0 0	108 0 0 to 109 0 0	25 0 0 to 25 12 6
18	59⅜	101 15 0 to 102 0 0	102 15 0 to 103 0 0	107 0 0 to 118 0 0	108 0 0 to 109 0 0	25 0 0 to 25 12 6
19	59¾	100 0 0 to 100 10 0	101 0 0 to 101 10 0	107 0 0 to 118 0 0	109 0 0 to 110 0 0	25 0 0 to 25 12 6
20	59⅞	100 15 0 to 101 0 0	101 15 0 to 102 0 0	109 0 0 to 120 0 0	109 0 0 to 110 0 0	24 17 6 to 25 10 0
21	60¼	100 15 0 to 101 0 0	101 15 0 to 102 0 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	24 17 6 to 25 10 0
22	60⅜	99 5 0 to 99 10 0	100 5 0 to 100 10 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	24 15 0 to 25 7 6
25	60¾	98 0 0 to 98 10 0	99 0 0 to 99 5 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	24 17 6 to 25 7 6
26	61¼	96 0 0 to 96 5 0	97 0 0 to 97 5 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	24 15 0 to 25 10 0
27	61¾	98 10 0 to 99 0 0	99 10 0 to 100 0 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	24 15 0 to 25 7 6
28	58¾	97 15 0 to 98 0 0	98 15 0 to 99 0 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	24 15 0 to 25 7 6
29	58	99 0 0 to 99 5 0	100 0 0 to 100 5 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	24 17 6 to 25 7 6
Sept.						
1	59	100 15 0 to 101 0 0	101 15 0 to 102 0 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	24 17 6 to 25 10 0
2	61	101 2 6 to 101 5 0	102 2 6 to 102 5 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	24 15 0 to 25 7 6
3	61	101 10 0 to 101 15 0	102 10 0 to 102 15 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	24 15 0 to 25 7 6
4	61	101 7 6 to 101 12 6	102 7 6 to 102 12 6	110 0 0 to 120 0 0	109 0 0 to 110 0 0	25 0 0 to 25 12 6
5	61	101 0 0 to 101 5 0	102 0 0 to 102 5 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	25 2 6 to 25 17 6
8	61	100 5 0 to 100 10 0	101 5 0 to 101 10 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	25 2 6 to 25 17 6
9	61	100 10 0 to 100 15 0	101 0 0 to 101 5 0	109 0 0 to 120 0 0	108 0 0 to 109 0 0	25 2 6 to 25 17 6
10	61	100 0 0 to 100 5 0	100 15 0 to 101 0 0	[illegible] 0 0 to 1[illegible]0 0 0	108 0 0 to 109 0 0	25 5 0 to 26 0 0

METAL MARKETS

COPPER.—The standard market has seen some fluctuation during the month of August. Prices in the early part of the month declined considerably, about £90. 10s. cash being touched. Subsequently a revival set in, carrying values to £102, but latterly the tone eased off again. These fluctuations are, of course, not so much due to variations in the actual copper position, as to the vagaries of speculative sentiment. There is no doubt that, during the recent upward movement in copper in America, a considerable amount of speculation for the rise was indulged in in the London standard market, and the consequence of this is that the market became somewhat top-heavy and unwieldy and liable to be affected by outside considerations. Rather easier stock markets in Wall Street had a somewhat unsettling effect for a time, as also had the reports of the unsatisfactory labour position in the United States. There have, however, been frequent "shake-outs" in the market, which has no doubt consolidated the position, and, on any set-back, fresh buying for the rise is noticeable. Meanwhile the margin between standard copper and refined is fairly wide, and forth at reason it may be that no material decline is probable in standard. The present price of refined, however, does not seem any too cheap, having regard to the cost of production in America, and although the demand for the metal has been growing, it still seems somewhat doubtful whether it is sufficient both to use up the present output as well as to absorb the surplus stocks which were on hand. Indeed, during the first half of the year it is stated that the surplus in America had not diminished at all. Business here with consumers was on quite a good scale at one time, but latterly there seems to be less anxiety to buy, and there seems to be considerable competition for the orders which were going. Of course, during the upward movement in America much copper found its way into the hands of dealers and speculators, and this could be resold at under the producers' present price, and still leave a good profit to holders. When this gets used up, doubtless producers may have the market again in their own hands, but meanwhile it is rumoured that there are prospects of the American Copper Export Association being dissolved before long, which of course might result in competition among the various producers with the natural effect upon prices. The manufactured copper business in this country has been fairly good. Makers are well sold, while India has been buying for delivery up to the first quarter of next year. This remark at least applies to yellow metal.

Average prices of cash standard copper: August 1919, £97. 11s. 5d.; July 1919, £90. 14s. 5d.; August 1918, £122. 5s.; July 1918, £120. 3s. 3d.

TIN.—This market has also seen some fluctuation during the period under review. Early in the month prices were firm, advancing to about £276 cash. This was followed by a sharp reaction, when prices declined to £2[illegible]0 for prompt metal. Values later improved again to about £274. 10s., and finally relapsed to £273. A very good business was moving in the standard market in the early part of the month, but latterly the turnover showed an inclination to taper off, which might be partly due to the fact that at the moment there seems no particular feature in the market to attract speculators in either direction. At one time a large business was put through for America, but latterly, although the local demand there seems to be fairly good, there has not been so much fresh business offering to this side. No doubt a pause is only to be expected, until the recent purchases have been digested. In the meantime there has been a considerable inquiry reported from Germany for tin, and it is estimated that that country could take as much as from 3,000 tons to 4,000 tons in order to get properly equipped for resuming industry. Of course the financial aspect of the business is rather a difficult question, as some buyers are only willing to pay for the tin against its arrival, while sellers here wish to do business on f.o.b. terms. A fair business has been moving in the East, although at one time sellers there were very reserved. Latterly they have shown more inclination for business, although it apparently could only be put through at high prices. At one time the price advanced to £278, although it subsequently declined about £6 from that level. Business with home consumers has latterly been showing some improvement.

Average prices of cash standard tin: August 1919, £271. 8s.; July 1919, £253. 5s. 1d.; August 1918, £380. 16. 8d.; July 1918, £359. 17s. 9d.

LEAD.—This market maintained a fairly steady tone

THE LONDON METAL EXCHANGE.
per Standard Ounce.

Zinc (Spelter)		Standard Tin — Cash		Standard Tin — 3 mos.	
£ s. d.	to £ s. d.	£ s. d.	to £ s. d.	£ s. d.	to £ s. d.
38 10 0	to 39 0 0	260 0 0	to 261 0 0	254 10 0	to 254 15 0
38 10 0	to 40 0 0	266 5 0	to 266 15 0	259 10 0	to 260 15 0
39 0 0	to 40 10 0	270 0 0	to 270 10 0	264 15 0	to 265 0 0
39 0 0	to 40 10 0	270 0 0	to 270 10 0	263 15 0	to 264 0 0
39 0 0	to 40 10 0	271 10 0	to 272 0 0	266 10 0	to 267 0 0
40 10 0	to 41 10 0	271 0 0	to 272 0 0	265 10 0	to 265 15 0
41 0 0	to 42 0 0	272 0 0	to 272 10 0	267 0 0	to 267 5 0
40 10 0	to 41 10 0	274 10 0	to 275 0 0	269 10 0	to 270 0 0
40 0 0	to 41 0 0	272 10 0	to 273 0 0	269 0 0	to 269 10 0
40 0 0	to 41 0 0	273 10 0	to 274 0 0	269 10 0	to 270 0 0
39 5 0	to 40 5 0	272 10 0	to 273 0 0	268 10 0	to 268 17 6
38 10 0	to 39 10 0	271 0 0	to 272 0 0	268 10 0	to 269 0 0
38 10 0	to 39 10 0	271 10 0	to 272 0 0	267 5 0	to 267 10 0
37 15 0	to 38 15 0	271 0 0	to 271 10 0	266 5 0	to 266 15 0
38 5 0	to 39 5 0	272 10 0	to 273 0 0	257 5 0	to 267 15 0
39 15 0	to 40 15 0	275 10 0	to 276 0 0	268 15 0	to 269 0 0
40 10 0	to 41 10 0	279 0 0	to 280 0 0	271 10 0	to 271 15 0
41 0 0	to 42 0 0	278 10 0	to 279 0 0	272 10 0	to 273 0 0
41 5 0	to 42 5 0	279 10 0	to 280 0 0	274 0 0	to 274 5 0
41 0 0	to 41 15 0	279 0 0	to 280 0 0	274 0 0	to 274 5 0
40 5 0	to 41 5 0	282 10 0	to 283 0 0	275 5 0	to 275 10 0
40 0 0	to 41 0 0	282 0 0	to 283 0 0	276 0 0	to 276 10 0
40 5 0	to 41 5 0	281 0 0	to 282 0 0	274 10 0	to 275 0 0

throughout the month of August. Values advanced in the middle of the month to £25. 2s. 6d. for August shipment metal, and at the close the quotation was only about 5s. less than this, while £25. 7s. 6d. was quoted for November. A fair turnover has taken place on the Metal Exchange, a good deal of the metal bought having evidently been on speculative account, and some conjecture is indulged in as to the effect on the market when this comes out for resale. Apart from this, a good demand has been seen from the consuming trades, this remark applying particularly to the cable-making business. This line seems particularly active, and there is talk of some works putting on a night shift. Purchases have been made for as far forward as February of next year. As regards the sheet and pipe business, this has not been very active, being dependent upon the building trade, which has not yet, despite all the talk, got properly started. English makers are well sold and the Government appear to have the situation very much in their own hands, as competition from America and other overseas sources is absent.

Average prices of soft pig lead: August 1919, £25. 1s. 7d.; July 1919, £23. 14s. 2d.; August 1918, £29.; July 1918, £29.

SPELTER.—Like other metals, this article has seen some variation in price during the last few weeks. Prices about the middle of August declined to £38. 10s. for August shipment and £39 for November, and after showing some recovery declined again to £38. 5s. for August and £39. 5s. for November. The reason of the decline toward the end of the month was somewhat obscure, as the Government have firmly maintained their prices, which were £44 for Prime Western and £44. 10s. for English. The American market was above the parity of prices here, while English makers could not turn out the metal at the figures which were current on the Metal Exchange. Values appear to have become depressed by some resales of speculative parcels, while some metal which had arrived, and for which buyers could not apparently at the moment be found, weighed somewhat heavily upon the market. At the lower level, the tone became rather firmer latterly. Business with the consuming trades has been on a fair scale, and a gratifying feature has been the improvement in the galvanized sheet business, which should ultimately make for an increased business in this metal. At the present time, consumers generally do not appear to be well covered, and in view of the weakness of the market on 'Change, have been confining their purchases to near-by requirements only. The low rate of the American exchange must have a considerable influence on this market in view of the increase in cost of importing metal from the United States.

Average prices of spelter: August 1919, £39. 16s. 9d., July 1919, £42. 3s. 10d.; August 1918, £52; July 1918, £52.

ZINC DUST.—The stocks of Australian on spot seem to be pretty well disposed of, and most of the business moving now is for forward shipment. The quotation stands at £68 to £70 per ton c.i.f., for Australian high grade (88 to 92%).

ANTIMONY.—The price of English regulus was advanced by £2 to £42 per ton, at which a fair trade was moving, especially for export. Since then the price has been advanced to £45. Foreign on spot is not plentiful and stocks are well held. For import, Chinese might have been had at £40 to £41 c.i.f. at one time, but in view of the last advance in English doubtless more will be asked now.

ARSENIC.—The market has been quiet but firm, and the price of white is about £58 to £60 per ton delivered London.

BISMUTH.—12s. 6d. nominal per lb.

CADMIUM.—6s. 6d. to 6s. 9d. per lb.

ALUMINIUM.—£150 per ton for the home trade.

NICKEL.—For the home trade £205 per ton, while for export the price is £210.

COBALT METAL.—12s. 6d. to 13s. per lb.

COBALT OXIDE.—7s. 9d. per lb.

PLATINUM.—450s. nominal per oz.

PALLADIUM.—500s. nominal per oz.

QUICKSILVER.—£23. 10s. to £24. 10s. per bottle.

SELENIUM.—12s. to 15s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER.—Quiet at about £40 per ton.

MANGANESE ORE. — The market has been firm. Indian grades are quoted at about 2s. 3d. to 2s. 4d per unit c i.f. U.K.

TUNGSTEN ORES.—Wolframite 65% and scheelite 65% are quoted at 32s. 6d. per unit.

MOLYBDENITE.—85% is quoted at 75s. per unit.

SILVER.—The market has been strong on Chinese buying, but declined when this ceased. At the end of August spot standard bars were quoted at 58d.

CORUNDUM.—Nominal.

GRAPHITE.—80%, £35 to £40 c.i.f. U.K.

IRON AND STEEL.—The pig-iron markets in the Cleveland district underwent somewhat of a lull, owing to the holiday season, but latterly business has been settling down again. The situation in respect of foundry iron is not quite so stringent, but the tone remains firm. The quotations at present are 164s. for No. 1, 160s. for No. 3 and No. 4 foundry, and about 157s. for No. 4 forge. Business in steel has been somewhat difficult to negotiate as the main inquiry is for ship-plates, which are difficult to procure owing to the well sold conditions of works. A good deal has been heard of American competition, although this latterly seems a less serious factor in the home markets, which no doubt is largely due to the fall in the rate of exchange. In overseas markets the American price seems still to be under ours, but the disparity between the two appears to be less marked than it was at one time. Fair quantities of American billets and semi-manufactured metal generally have been coming in, but latterly business in American products here seems to have tapered off.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
July, 1918	716,010	20,189	736,199	3,127,174
August	719,849	20,361	740,210	3,144,211
September	686,963	21,243	708,206	3,008,267
October	667,955	11,809	679,764	2,887,455
November	640,797	17,904	656,701	2,797,983
December	630,505	10,740	641,245	2,723,836
Year 1918	8,197,959	221,734	8,419,693	35,768,688
January, 1919	662,205	13,854	676,059	2,871,718
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,847	724,945	3,079,583
June	682,603	19,776	[illegible]	[illegible]
July	705,523	19,974	[illegible]	[illegible]

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1918	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	196,294
September 30	179,[illegible]9	12,108	4,889	196,395
October 31	173,153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637
January 31, 1919	16[illegible]	11,848	[illegible]	[illegible]
February 28	172,359	11,868	4,[illegible]	188,491
March 31	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	[illegible]	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	[illegible]

Cost and Profit on the Rand

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d	s. d.	£
July, 1918	2,167,869	27 10	21 2	6 6	702,360
August	2,158,431	28 1	21 7	6 3	676,146
September	2,060,635	28 2	22 0	5 10	600,330
October	2,015,144	28 0	22 5	5 3	531,774
November	1,899,925	28 5	23 1	5 1	480,102
December	1,855,691	28 7	23 0	5 6	507,860
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129
January, 1919	1,942,329	28 9	23 0	5 8	547,793
February	1,816,352	28 9	23 2	5 6	498,204
March	2,082,469	28 2	22 6	5 6	573,582
April	1,995,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715
June	2,032,169	28 4	22 4	5 10	592,361

Production of Gold in Rhodesia and West Africa

	Rhodesia.		West Africa.	
	1918	1919	1918	1919
	£	£	£	£
January	253,807	211,917	107,863	104,063
February	232,023	220,885	112,865	112,616
March	230,023	225,808	112,605	112,543
April	239,916	213,160	117,520	109,570
May	239,205	218,057	126,290	100,827
June	225,447	214,215	120,273	106,612
July	251,740	214,919	117,581	102,467
August	257,096	—	120,526	—
September	247,885	—	115,152	—
October	136,780	—	61,461	—
November	145,460	—	108,796	—
December	192,870	—	112,621	—
Total	2,652,250	1,518,961	1,333,553	748,698

Transvaal Gold Outputs.

	July, 1919	
	Treated	Value
	Tons	£
Aurora West	13,000	13,459
Bantjes	—	—
Barrett	—	—
Brakpan	[illegible]	92,854
City & Suburban	[illegible]	30,902
City Deep	55,000	106,778
Cons. Langlaagte	47,300	55,422
Cons. Main Reef	50,350	73,530
Crown Mines	179,000	240,381
Durban Roodepoort Deep	11,700	11,357
East Rand P. M.	125,000	149,974
Ferreira Deep	35,000	50,552
Geduld	43,700	66,126
Geldenhuis Deep	51,190	58,232
Ginsberg	—	—
Glynn's Lydenburg	3,810	7,490
Goch	14,980	12,721
Government G.M. Areas	122,000	212,118
Heriot	12,660	16,498
Jupiter	25,100	27,632
Kleinfontein	51,000	68,343
Knights Central	25,500	30,871
Knights Deep	95,000	75,088
Langlaagte Estate	42,000	50,281
Luipaard's Vlei	22,250	22,258
Meyer & Charlton	15,000	40,582
Modderfontein	81,000	172,858
Modderfontein B	57,000	122,600
Modderfontein Deep	43,500	95,587
New Unified	12,000	12,018
Nourse	41,400	53,651
Primrose	19,000	18,641
Princess Estate	20,200	27,705
Randfontein Central	161,000	177,974
Robinson	40,600	43,344
Robinson Deep	55,500	73,252
Roodepoort United	24,400	22,333
Rose Deep	56,000	64,580
Simmer & Jack	58,400	69,952
Simmer Deep	45,200	50,484
Springs	38,500	66,372
Sub Nigel	11,000	28,135
Transvaal G.M. Estates	15,540	26,296
Van Ryn	34,500	33,923
Van Ryn Deep	48,300	107,991
Village Deep	43,200	64,119
Village Main Reef	18,700	25,664
West Rand Consolidated	33,260	38,865
Witwatersrand (Knights)	34,600	41,640
Witwatersrand Deep	—	—
Wolhuter	32,000	36,756

West African Gold Outputs.

	July, 1919	
	Treated	Value
	Tons	£
Abbontiakoon	7,717	11,776
Abosso	7,300	12,470
Ashanti Goldfields	7,821	37,568
Prestea Block A	15,189	25,345
Taquah	4,520	11,994
Wassau	2,641	3,332

Rhodesian Gold Outputs.

	July, 1919	
	Treated	Value
	Tons	£
Antelope	3,025	4,070
Cam & Motor	—	—
Eldorado Banket	1,040	3,697
Falcon	16,447	22,208*
Gaika	3,103	5,477
Globe & Phœnix	6,461	7,749†
Lonely Reef	4,650	24,916
Rezende	5,600	14,297
Rhodesia, Ltd.	345	678
Shamva	54,366	35,851
Transvaal & Rhodesian	1,800	4,750
Wanderer	—	—

* Gold, Silver and Copper ; † Ounces Gold.

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
August, 1918	*	76,156	*	*
September	*	74,057	*	*
October	*	71,439	*	*
November	1,444	70,711	72,155	306,494
December	2,739	61,314	64,053	272,208
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	*nil*	66,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316 862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410

* By direction of the Federal Government the export figures from July, 1916, to November, 1918, were not published.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1918	1919	1918	1919	1918	1919
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	25,000	18,000
February	58,113	46,955	45,470	43,330	28,000	24,000
March	65,412	40,267	48,020	48,000	30,000	16,000
April	29,620	63,818	47,600	61,200	30,000	24,000
May	87,885	37,456	46,740	38,200	45,000	16,000
June	45,765	—	51,420	44,600	32,000	17,000
July	64,347	—	51,000	42,060	25,000	22,000
August	61,163	—	44,600	—	21,000	20,000
September	65,751	—	45,900	—	32,000	—
October	*	—	54,400	—	40,000	—
November	*	—	38,200	—	25,000	—
December	70,674	—	56,281	—	38,000	—
Total	674,655	225,432	578,213	314,490	370,000	157,000

* Figures not received.

Australasian Gold Outputs.

	July, 1919	
	Treated Tons	Value £
Associated	6,110	7,883
Associated Northern Blocks — Iron Duke	—	1,956*
Associated Northern Blocks — Victorious	—	—
Blackwater	2,160	4,035
Bullfinch	5,700	5,828
Golden Horseshoe	7,548	14,238
Great Boulder Prop.	6,861	19,949
Ivanhoe	10,225	21,118
Kalgurli	3,217	7,455
Lake View & Star	—	—
Mount Boppy	2,980	4,650
Oroya Links	1,523	15,338†
Progress	1,450	1,713
Sons of Gwalia	13,057	18,546
South Kalgurli	7,533	11,914
Talisman	225	2,962
Waihi	15,153	25,295‡
Waihi Grand Junction	5,620	8,155‡

* Surplus; † Total receipts; ‡ Gold and Silver to August 9.

Miscellaneous Gold Output.

	July, 1919	
	Treated Tons	Value £
Barramia (Sudan)	—	—
Esperanza (Mexico)	15,987	3,250
Frontino & Bolivia (Colombia)	2,620	8,861
Nechi (Colombia)	89,888*	30,338†
Ouro Preto (Brazil)	7,600	11,000
Pato (Colombia)	165,428*	121,725†
Philippine Dredges (Philippine Islands)	—	383§
Plymouth Cons. (California)	10,400	12,876
St. John del Rey (Brazil)	—	40,000
Santa Gertrudis (Mexico)	35,100	28,860††
Sudan Gold Field (Sudan)	1,530	1,470

* Cubic yards. † Dollars. § Ounces, fineness not stated. †† Profit, gold and silver.

Production of Gold in India.

	1916	1917	1918	1919
	£	£	£	£
January	192,150	190,047	176,030	162,270
February	183,264	180,904	173,343	153,775
March	186,475	189,618	177,950	162,790
April	192,208	185,835	176,486	162,550
May	193,604	184,874	173,775	164,080
June	192,469	182,426	*174,375	162,996
July	191,404	179,660	171,950	163,795
August	192,784	181,005	172,105	—
September	192,330	183,630	170,360	—
October	191,502	182,924	167,740	—
November	192,298	182,388	157,176	—
December	205,164	190,852	170,630	—
Total	2,305,652	2,214,163	2,061,920	1,034,256

Indian Gold Outputs.

	July, 1919	
	Tons Treated	Fine Ounces
Balaghat	2,750	2,193
Champion Reef	11,856	7,157
Hutti (Nizam's)	—	—
Jibutil	—	—
Mysore	22,422	13,534
North Anantapur	1,000	914
Nundydroog	8,765	6,481
Ooregum	12,900	7,370

Base Metal Outputs

		July, 1919
Arizona Copper	Short tons copper	1,200
British Broken Hill	Tons lead concentrate	—
	Tons zinc concentrate	—
	Tons carbonate ore	—
Broken Hill Block 10	Tons lead concentrate	—
	Tons zinc concentrate	—
Burma Corp.	Tons refined lead	1,619
	Oz. refined silver	203,152
Cordoba Copper		—
Fremantle Trading	Long tons lead	—
North Broken Hill	Tons lead	—
	Oz. silver	—
Poderosa	Tons copper ore	106
Rhodesian Broken Hill	Tons lead and zinc	1,219
Tanganyika	Long tons copper	2,015
Tolima	Tons silver-lead concentrate	45
Zinc Corp.	Tons zinc concentrate	—
	Tons lead concentrate	—

Imports of Ores and Metals into United Kingdom

		Aug. 1919	Year 1919
Iron Ore	Tons	669,738	3,858,240
Manganese Ore	Tons	13,725	221,005
Copper and Iron Pyrites	Tons	25,848	203,869
Copper Ore	Tons	516	10,384
Copper Precipitate	Tons	2,315	[illegible]
Copper Metal	Tons	[illegible]	81,714
Tin Concentrate	Tons	1,623	[illegible]
Tin Metal	Tons	1,353	12,067
Lead, Pig and Sheet	Tons	7,505	[illegible]
Zinc (Spelter)	Tons	5,535	67,271
Quicksilver	Lb.	379,704	2,074,791
Zinc Oxide	Cwt	44,935	104,306
Barytes	Cwt.	[illegible]	291,085
Rock Phosphate	Tons	19,341	257,582
Brimstone	Cwt.	10,565	114,789
Boracic Compounds	Cwt.	[illegible]	172,189
Nitrate of Potash	Cwt.	66	121,879
Petroleum:			
Crude	Gallons	1,723,335	4,866,734
Lamp Oils	Gallons	12,547,058	107,951,475
Motor Spirit	Gallons	12,942,707	140,935,081
Lubricating Oils	Gallons	5,099,116	40,542,485
Gas Oil	Gallons	2,409,321	13,269,287
Fuel Oil	Gallons	10,674 942	155,183,035
Total Petroleum	Gallons	45,396,482	462,748,047

United States Metal Exports and Imports.

Exports.	May Tons.	June Tons.	Imports.	May Tons.	June Tons.
Copper Ingots	8,342	10,826	Antimony	261	722
Copper Sheets	382	224	Tin Ore	2	—
Copper Wire	1,768	2,127	Tin	200	50
Lead, Pig	1,017	7,492	Manganese Ore	19,644	31,550
Zinc	5,025	10,730	Tungsten Concentrate	285	338
Zinc Sheets	596	746	Pyrites	53,262	50,545

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Year 1918 Tons	July 1919 Tons	Year 1919 Tons
Nigeria:			
Abu	33	1	13
Anglo-Continental	207	–	79
Benue	146	4	53
Berrida	—	–	1
Bisichi	275	20	90
Bongwelli	17	6	29
Dua	60	3	40
Ex-Lands	312	30	208
Filani	37	3	14
Forum River	274	13	55
Gold Coast Consolidated	30	5	20
Gurum River	69	8	65
Jantar	141	8	65
Jos	228	15	136
Kaduna	178	7	120
Kano	60	11	93
Kassa-Ropp	133	12	84
Kefli	118	–	30
Kuru	12	24	173
Kuskie	21	1	4
Kwall	108	–	7
Lower Bisichi	99	5	52
Lucky Chance	27	3	19
Minna	40	5	21
Mongu	476	52	312
Naraguta	478	31	215
Naraguta Extended	280	54	149
New Lafon	198		125
Nigerian Tin	87		25
Ninghi	—	5	25
N. N. Bauchi	425	20	205
Offin River	120		32
Rayfield	689	40	397
Ropp	836	87	596
Rukuba	132	4	23
South Bukeru	94	4	52
Sybu	40	2	19
Tin Areas	96	4	42
Tin Fields	108	13	101
Toro	17	–	3
Federated Malay States			
Chenderiang	179		52
Gopeng	979	65	506
Idris Hydraulic	136	21	132
Ipoh	245	13	90
Kamunting	236		96
Kinta	478	39	252
Kledang	28		10
Lahat	369	44	242
Malayan Tin	730	46	398
Pahang	1,877	187	1,258
Rambutan	407	9	90
Sungei Besi	408	60	210
Tekka	508	30	263
Tekka-Taiping	400	30	186
Tronoh	1,364	129	850
Tronoh South	133	–	
Cornwall:			
Cornwall Tailings	140		–
Dolcoath	787	60	444
East Pool	1,336	81	613
Geevor	392	–	186
South Crofty	598	55	359
Other Countries:			
Aramayo Francke (Bolivia)	1,816	180	1,253
Briseis (Tasmania)	327	18	142
Deebook (Siam)	398		160
Mawchi (Burma)	658	85	465
Porco (Bolivia)	227	27	162
Renong (Siam)	615	70	555
Rooiberg Minerals (Transvaal)	335	12	186
Siamese Tin (Siam)	989	44	382
Tongkah Harbour (Siam)	1,528	107	672
Zaaiplaats (Transvaal)	563	12	314

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	485	417	531	667	678	613
February	469	358	528	646	668	623
March	5[illegible]2	418	547	655	707	606
April	482	444	486	555	584	546
May	480	357	536	509	525	475
June	460	373	510	473	492	476
July	432	455	506	479	545	467
August	228	438	498	551	571	—
September	289	442	535	538	520	—
October	272	511	584	578	491	—
November	283	467	679	621	472	—
December	326	533	654	655	518	—
Total	4,708	5,213	6,594	6,927	6,771	3,806

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
July 1	170¼	£34,035	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	146¼	£33,816	£231 4 6
August 12	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	142½	£28,793	£202 1 2
September 23	145¾	£29,639	£203 7 2
October 7	136¾	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	141¼	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	163¾	£25,170	£150 19 0
December 16	175½	£26,032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918	4,094	£786,511	£192 0 0
January 13, 1919	160	£20,888	£130 11 0
January 27	135½	£17,000	£125 10 7
February 10	155	£17,441	£11[illegible] 19 10
February 24	142	£15,015	£105 14 10
March 10	144½	£18,123	£125 8 5
March 24	148½	£17,877	£120 7 8
April 7	137¼	£15,288	£111 8 10
April 22	134½	£15,053	£111 18 1
May 5	129	£14,919	£115 13 2
May 19	126½	£15,814	£125 5 0
June 2	140	£17,185	£122 15 0
June 16	139	£17,486	£125 15 9
June 30	136	£16,782	£123 8 0
July 14	145	£18,250	£125 17 3
July 28	122	£16,959	£138 16 11
August 11	127½	£17,125	£134 6 5
August 25	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6

Details of Redruth Tin Ticketings

	August 11 Tons Sold	August 11 Realized per ton £ s. d.	August 25 Tons Sold	August 25 Realized per ton £ s. d.
E. Pool & Agar, No. 1	10	133 12 6	10	138 15 0
" " No. 1a	10	134 10 0	10	138 15 0
" " No. 1b	10	132 10 0	10	138 15 0
" " No. 1c	—	—	—	—
Dolcoath, No. 1	9	139 0 0	8	145 0 0
" No. 1a	9	140 12 6	8	147 5 0
" No. 1b	9	140 15 0	8	147 5 0
" No. 2	3	66 10 0	3	62 0 0
" A	—	—	1	126 0 0
South Crofty, No. 1	11	135 5 0	11	139 10 0
" " No. 1a	11	135 5 0	11	139 15 0
Grenville Utd., No. 1	8	128 15 0	8	135 15 0
" " No. 1a	7	129 15 0	8	134 17 6
" " No. 2	2	63 5 0		—
Tincroft Mines, No. 1	5½	144 0 0	5½	150 0 0
" " No. 1a	6	145 15 0	6	150 0 0
Levant Mines, No. 1	8	141 0 0	8	148 10 0
" " No. 1a	7	142 0 0	7	147 0 0
Wheal Bellan	2	143 10 0	—	—
Hingston Downs	—		5	153 12 6
Peever	—		2	111 12 6
Trencrom	—		1	125 0 0
Total	127½		130½	

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons. * Figures not published.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January ...	4,395	4,316	3,558	3,149	3,765
February ...	3,780	3,372	2,755	3,191	2,673
March	3,653	3,696	3,286	2,608	2,819
April	3,619	3,177	3,251	3,308	2,855
May	3,823	3,729	3,413	3,332	3,404
June	4,048	3,435	3,489	2,950	2,873
July	3,544	3,517	3,253	3,373	3,756
August	4,046	3,732	3,413	3,259	2,955
September .	3,932	3,636	3,154	3,166	—
October......	3,797	3,681	3,436	2,870	—
November .	4,059	3,635	3,300	3,131	—
December .	4,071	3,945	3,525	3,023	—
	46,767	43,871	39,833	37,370	25,100

Stocks of Tin

Reported by A. Strauss & Co. Long Tons.

	July 31, 1919	August 31, 1919
	Tons	Tons
Straits and Australian Spot	1,972	573
Ditto, Landing and in Transit	768	1,010
Other Standard, Spot and Landing ...	544	433
Straits, Afloat....................................	1,961	4,664
Australian, Afloat.............................	252	252
Banca, in Holland..........................	—	1,144
Ditto, Afloat	435	673
Billiton, Spot	—	—
Billiton, Afloat	—	—
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	435	840
Total Afloat for United States............	6,280	7,648
Stock in America	50	920
Total	12,697	18,157

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	July 1919	August 1919
	Tons	Tons
Shipments from:		
Straits to U.K.	1,562	4,164
Straits to America	5,305	3,825
Straits to Continent........	435	840
Straits to Other Places	2,487	1,363
Australia to U.K.	100	100
U.K. to America	1,000	1,720
Imports of Bolivian Tin into Europe..	295	839
Supply:		
Straits	7,302	8,829
Australian	100	100
Billiton	60	—
Banca	1,955	—
Standard	906	1,129
Consumption:		
U.K. Deliveries..............................	1,949	1,333
Dutch ,, ...	102	60
American ,, ...	50	4,345
Straits, Banca & Billiton, Continental Ports, etc.	290	875
Straits in hands of Malay Government	–	
,, controlled by U.S. Government	—	—
,, ,, ,, French and Italian Governments.	—	—
Banca in Trading Company's hands ..	733	

PRICES OF CHEMICALS. Sept. 10.

		£	s.	d
Alum	per ton	17	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous...............	per lb.		1	10
,, 0·880 solution	per ton	33	0	0
,, Carbonate	per lb.			6½
,, Chloride of, grey......	per ton	47	0	0
,, ,, ,, pure......	per cwt.	4	0	0
,, Nitrate of	per ton	60	0	0
,, Phosphate of............	,,	110	0	0
,, Sulphate of	,,	19	0	0
Antimony Sulphide	per lb.		1	3
Arsenic, White........................	per ton	60	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	55	0	0
Bleaching Powder, 35% Cl.	,,	15	0	0
Borax	,,	39	0	0
Copper, Sulphate of	,,	43	0	0
Cyanide of Sodium, 100%.........	per lb			10
Hydrofluoric Acid	,,			7
Iodine..	,,		16	0
Iron, Sulphate of......................	per ton	5	0	0
Lead, Acetate of, white	,,	85	0	0
,, Nitrate of	,,	56	0	0
,, Oxide of, Litharge	,,	45	0	0
,, White	,,	50	0	0
Lime, Acetate, brown..............	,,	11	0	0
,, ,, grey 80%............	,,	17	0	0
Magnesite, Calcined	,,	22	0	0
Magnesium Chloride	,,	16	0	0
,, Sulphate...............	,,	11	0	0
Methylated Spirit 64° Industrial	per gal.		5	7
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	,,		1	6
,, Carbonate	per ton	95	0	0
,, Chlorate	per lb.		1	1
,, Chloride 80%	per ton	25	0	0
,, Hydrate (Caustic) 90%	,,	160	0	0
,, Nitrate......................	,,	60	0	0
,, Permanganate	per lb		3	3
,, Prussiate, Yellow	,,		1	9
,, Sulphate, 90%	per ton	30	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	52	0	0
,, Arsenate 45%	,,	60	0	0
,, Bicarbonate	,,	9	10	0
,, Bichromate	per lb.			11
,, Carbonate (Soda Ash)...	per ton	12	10	0
,, ,, (Crystals) ...	,,	4	5	0
,, Chlorate.....................	per lb.			7
,, Hydrate, 76%	per ton	24	0	0
,, Hyposulphite	,,	16	10	0
,, Nitrate, 95%..............	,,	21	0	0
,, Phosphate	,,	26	10	0
,, Prussiate.....................	per lb.			7½
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)......	,,	3	0	0
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide......................	,,	19	0	0
Sulphur, Roll..........................	,,	21	0	0
,, Flowers......................	,,	23	0	0
Sulphuric Acid, Non-Arsenical... 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%...	,,	5	0	0
Tartaric Acid...........................	per lb.		3	0
Zinc Chloride	per ton	23	0	0
Zinc Sulphate	,,	22	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Sept. 6 1918 £	s.	d.	Sept. 5 1919 £	s.	d.
RAND:						
Brakpan	4	0	0	3	10	0
Central Mining (£8)	7	10	0	9	5	0
City & Suburban (£4)		17	0		8	9
City Deep	3	0	0	2	18	9
Consolidated Gold Fields	1	18	9	1	18	9
Consolidated Langlaagte	1	0	0	1	0	0
Consolidated Main Reef		15	0		13	6
Consolidated Mines Selection (10s).	1	7	9	1	5	6
Crown Mines (10s.)	2	7	6	2	12	6
Daggafontein	1	6	3	1	5	0
Durban Roodepoort Deep		10	0		7	6
East Rand Proprietary		4	6		5	6
Ferreira Deep		15	6		12	6
Geduld	1	18	9	2	12	6
Geldenhuis Deep		13	0		10	0
Gov't Gold Mining Areas	4	13	0	4	13	9
Heriot	1	0	0		11	3
Johannesburg Consolidated	1	3	0	1	11	3
Jupiter		4	9		4	6
Kleinfontein		16	6		12	3
Knight Central		4	6		6	6
Knights Deep		8	0		8	3
Langlaagte Estate		15	6		18	9
Meyer & Charlton	4	12	6	4	8	9
Modderfontein (£4)	25	17	6	27	2	6
Modderfontein B	8	0	0	8	16	3
Modder Deep	8	1	3	8	7	6
Nourse		17	6		14	[illegible]
Rand Mines (5s.)	3	2	6	3	0	0
Rand Selection Corporation	4	6	3	3	13	9
Randfontein Central		13	0		15	0
Robinson (£5)		15	6		11	3
Robinson Deep A (1s.)	1	5	0	1	0	0
Rose Deep		18	9		16	3
Simmer & Jack		4	6		5	0
Simmer Deep		3	9		2	6
Springs	3	17	6	2	16	3
Sub Nigel	1	12	6	1	5	0
Union Corporation (12s. 6d.)		15	0		18	6
Van Ryn		19	6		17	6
Van Ryn Deep	3	16	3	3	15	0
Village Deep		18	9		15	0
Village Main Reef		12	6		11	6
Witwatersrand (Knight's)	1	6	3	1	1	3
Witwatersrand Deep		9	6		12	6
Wolhuter		5	0		4	3
OTHER TRANSVAAL GOLD MINES:						
Glynn's Lydenburg	1	3	9		18	9
Sheba (5s.)			9		2	3
Transvaal Gold Mining Estates		16	0		13	9
DIAMONDS IN SOUTH AFRICA:						
De Beers Deferred (£2 10s.)	16	10	0	23	17	6
Jagersfontein	4	16	3	6	2	6
Premier Deferred (2s. 6d.)	7	12	6	9	5	0
RHODESIA:						
Cam & Motor		11	0		5	6
Chartered British South Africa		16	6	1	0	9
Eldorado		5	9		4	3
Falcon	1	1	9		13	9
Gaika		14	6		15	6
Giant		8	6		8	0
Globe & Phœnix (5s.)	1	10	0	1	2	6
Lonely Reef	1	17	9	2	15	0
Rezende	5	6	3	5	5	0
Shamva	1	18	0	1	18	9
Willoughby's (10s.)		5	9		6	3
WEST AFRICA:						
Abbontiakoon (10s.)		4	3		4	9
Abosso		8	6		12	0
Ashanti (4s.)	1	0	6	1	1	9
Prestea Block A		4	0		5	9
Taquah		15	9		16	3
WEST AUSTRALIA:						
Associated Gold Mines		3	9		3	6
Associated Northern Blocks		4	6		3	9
Bullfinch		1	9		2	6
Golden Horse-Shoe (£5)	2	0	0	1	6	3
Great Boulder Proprietary (2s.)		11	0		9	3
Great Fingall (10s).		3	6		1	9
Ivanhoe (£5)	1	16	3	1	18	9
Kalgurli		9	0		9	6
Lake View & Oroya (10s.)		13	0	1	3	0
Sons of Gwalia		8	0		5	9
South Kalgurli (10s.)		5	3		5	6

GOLD, SILVER, *cont.*	Sept. 6 1918 £	s.	d.	Sept. 5 1919 £	s.	d.
OTHERS IN AUSTRALASIA:						
Blackwater, New Zealand		8	9		8	9
Consolidated G.F. of New Zealand		3	9		3	9
Mount Boppy, New South Wales		6	3			9
Progress, New Zealand		1	9		2	0
Talisman, New Zealand		12	0		8	9
Waihi, New Zealand	2	2	6	2	7	6
Waihi Grand Junction, New Z'lnd		16	6		14	0
AMERICA:						
Buena Tierra, Mexico		17	6		17	6
Camp Bird, Colorado		13	6	1	4	9
El Oro, Mexico		15	6	1	0	9
Esperanza, Mexico		8	9		19	9
Frontino & Bolivia, Colombia		12	6		5	9
Le Roi No. 2 (£5), British Columbia		13	0		11	3
Mexico Mines of El Oro, Mexico	6	5	0	7	5	0
Nechi (Pref. 10s.), Colombia		12	0		12	6
Oroville Dredging, Colombia		18	3	1	11	0
Plymouth Consolidated, California	1	2	6	1	7	0
St. John del Rey, Brazil		19	6		19	0
Santa Gertrudis, Mexico		14	3	1	14	0
Tomboy, Colorado		13	6		18	0
RUSSIA						
Lena Goldfields	1	7	6	1	19	0
Orsk Priority		14	0		13	9
INDIA						
Balaghat		4	3		6	6
Champion Reef (2s. 6d.)		5	6		4	3
Mysore (10s.)	2	13	9	1	17	6
North Anantapur		5	0		5	0
Nundydroog (10s.)	1	4	0		14	0
Ooregum (10s.)		19	6		16	6
COPPER:						
Arizona Copper (5s.), Arizona	2	8	9	2	0	0
Cape Copper (£2), Cape Province	2	10	0	2	12	6
Esperanza, Spain		7	6		5	9
Hampden Cloncurry, Queensland	1	6	0		17	6
Kyshtim, Russia	1	10	0	1	6	3
Mason & Barry, Portugal	3	2	6	2	3	9
Messina (5s.), Transvaal		5	0		5	0
Mount Elliott (£5), Queensland	3	10	0	3	15	0
Mount Lyell, Tasmania	1	11	[illegible]	1	3	[illegible]
Mount Morgan, Queensland	1	12	6	1	5	6
Mount Oxide, Queensland		8	0		7	0
Namaqua (£2), Cape Province	2	10	0	1	12	6
Rio Tinto (£5), Spain	70	0	0	*64	10	0
Sissert, Russia		17	6	1	2	6
Spassky, Russia	1	10	0	1	10	0
Tanalyk, Russia	1	16	3	1	12	6
Tanganyika, Congo and Rhodesia	4	3	0	4	15	0
LEAD-ZINC:						
BROKEN HILL						
Amalgamated Zinc	1	7	3	1	6	6
British Broken Hill	2	14	6	2	1	3
Broken Hill Proprietary (8s.)	3	13	9	2	7	0
Broken Hill Block 10 (£10)	1	18	9	1	5	0
Broken Hill North	3	10	6	2	12	6
Broken Hill South	14	0	0	2	5	0*
Sulphide Corporation (15s.)	1	8	0	1	1	6
Zinc Corporation (10s.)	1	11	3	1	1	9
ASIA						
Burma Corporation	4	8	0	9	5	0
Irtysh Corporation	1	10	[illegible]	1	15	[illegible]
Russian Mining		18	0		17	6
Russo-Asiatic	1	15	0	4	6	3
TIN:						
Aramayo Francke, Bolivia	2	16	3	4	0	0
Bisichi, Nigeria		15	6		13	9
Briseis, Tasmania		5	0		4	6
Dolcoath, Cornwall		10	6		11	6
East Pool, Cornwall	1	12	6		19	6
Ex-Lands Nigeria (2s.), Nigeria		2	6		3	6
Geevor (10s.) Cornwall	1	4	6	1	3	9
Gopeng, Malay	2	0	0	2	1	3
Ipoh Dredging, Malay		19	0	1	0	0
Kamunting, Malaya	1	12	6	2	6	3
Kinta, Malaya	2	7	6	2	10	0
Malayan Tin Dredging, Malay	2	5	0	2	5	0
Mongu (10s.), Nigeria		17	0	1	0	0
Naraguta, Nigeria		17	9		17	0
N. N. Bauchi, Nigeria (10s.)		8	0		8	[illegible]
Pahang Consolidated (5s.), Malay		14	6		15	3
Rayfield, Nigeria		15	0		15	3
Renong Dredging, Siam	2	8	9	2	8	9
Ropp (4s.), Nigeria	1	3	0	1	1	6
Siamese Tin, Siam	3	5	0	3	6	3
South Crofty (5s.), Cornwall	2	10	6		13	9
Tehidy Minerals (15s. pd.) Cornw'l		—		1	2	6
Tekka, Malay	4	5	1	4	5	0
Tekka-Taiping, Malay	3	17	6	5	7	6
Tronoh, Malay	2	10	0	2	2	6

* Share capital expanded.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

REFRACTORIES IN ZINC METALLURGY.

In December last we quoted a paper read by J. A. Audley before the Ceramic Society on refractories used in connection with the distillation of zinc. Mr. Audley has presented to the same society a second paper extending the references on the subject. These additional references are to papers not readily accessible and most of them not in English, and the author has therefore done a service to the industry in collecting them.

The author does not deal specially with the furnace bricks, for the consideration of them is not essentially different from that of high-grade refractories in general. It is in reality in their case mainly a matter of proper selection and suitable treatment of the materials, due regard being paid to the proportioning and grading of the grog. In a passing allusion in his previous paper to furnace bricks made from St. Louis clay there is no mention of the fact that the mixture used for making these bricks consisted of 40 clay to 60 grog, a much larger proportion of grog than is commonly employed in this country. Special treatment (washing, etc.) of the clay to increase its plasticity, or substitution (partly or wholly) of a more plastic clay than that ordinarily used, in order to permit the employment of a higher proportion of grog, deserves serious consideration in this connection, particularly as the best qualities of bricks are only needed at places where they come into direct contact with the flames.

The following are further analyses of St. Louis clay, all from the same mine, given by Mühlhäuser, in *Zeitschrift Angewandte Chemie* for 1903 :

	Al_2O_3	SiO_2	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Loss on ignition
Top of mine	34·95	49·00	2·45	0·80	0·58	—	—	13·00
	33·80	50·00	2·20	0·40	0·36	—	—	12·80
	34·64	49·60	1·96	1·20	0·66	—	—	12·90
Bottom	34·46	49·40	2·94	0·80	0·87	—	—	12·75
Average of above. Dried at 120° C	34·46	49·50	2·39	0·80	0·62	—	—	12·86
" " Calcined	39·26	56·39	2·72	0·91	0·71	—	—	0·00
Average of a year's production (a few years later) :								
a. Dried at 120°C.	35·02	50·02	2·76	0·70	0·46	0·06	0·17	12·51
b. Calcined	39·26	56·08	3·09	0·78	0·51	0·06	0·19	0·00

It will be noticed that the variations in composition are comparatively slight. The impurities in the St Louis clay—consisting of felspar, carbonate of lime, spherosiderite, limonite, gypsum, and pyrite, with a few quartz grains, and no more than traces of titanium—amount to only 1·57% of the clay ready for use, after drying at 120°C. The clay itself, passed through a sieve with 5,000 meshes per sq. cm., had the following composition, and melted at cone 30—31 :

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_3O	Loss on ignition
48·00	34·59	3·83	0·50	0·48	0·02	0·13	12·59

St. Louis clay thus comes near in composition to two German clays, from Girode and Hettenleidelheim.

	SiO_2	Al_2O_3	Fe_2O_3	Loss on ignition	Melting point
St. Louis Clay	48·00	34·59	3·83	12·59	Cone 30-31
Girode clay	48·50	35·10	1·80	13·06	" 34
Hettenleidelheim clay	49·23	34·57	2·05	12·15	" 33

On making St. Louis clay into a thin slip, and washing it through a No. 100 brass sieve until the water runs through nearly clear, then allowing to settle and decanting the water, and finally drying on a water bath the mud remaining as well as the crumbly residue on the sieve, the products analysed as follows :

	SiO_2	Al_2O_3	Fe_2O_3	CaO
St. Louis clay	50·02	35·02	2·76	0·70
Sieved clay	50·06	35·82	2·28	0·46
Residue	50·60	34·20	3·24	0·58

	MgO	K_2O	Na_2O	Loss on ignition
St. Louis clay	0·46	0·06	0·17	12·51
Sieved clay	0·60	0·05	0·04	12·49
Residue	0·40	0·09	0·16	12·47

The melting points proved to be the same for all three.

The fine clay was found to be highly plastic, whereas the residue was only slightly plastic, though the composition was nearly the same. This suggests at once that considerable increase in plasticity might be produced in other fireclays if a suitable washing process could be devised. In trials on a small scale it was found that to obtain practically all the clay in washed condition wet grinding was necessary, as boiling or dry grinding gave no more than 50 to 66% of the clay in washed condition.

Still another analysis of St. Louis clay, but after calcination, gave the following figures :

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O
Calcined St. Louis clay	56·08	39·26	3·09	0·78	0·51	0·07	0·19

In the former paper some analyses of old Belgian and Silesian retorts were given. The following analyses by Mühlhäuser (*Z. ang. Chem.*, 1902) of a Rhenish muffle and two American retorts are instructive for comparison :

	SiO_2	Al_2O_3	Fe_2O_3	ZnO	CaO	MgO	K_2O	Na_2O
Rhenish zinc muffle	68·84	20·38	2·52	6·42	0·60	0·12	—	—
Illinois zinc retort	44·68	32·52	3·60	19·10	0·10	0·00	0·11	0·20
Kansas zinc retort	52·06	28·34	2·40	16·88	0·06	0·42	—	—

It was stated that Schulze and Stelzner failed to establish the cause of the blue coloration of zinc spinel in zinc muffle or retort bodies, and categorically stated that it was not due to titanium, as they were unable to detect any titanium in the isolated blue spinel. They, however, alluded to Kersten's observation [Berzelius : *Jahresber. über d. Fortschr. d. phys. Wissenschaft*, 1840] that when zinc vapour was passed over ignited titanic acid (that is, titanium dioxide) the latter became blue, and also that when a solution of titantic acid in hydrogen sodium phosphate was ignited in hydrogen it became lavender blue, and treatment with water left a blue lower oxide of titanium, which became white on heating in an open vessel. Brandhorst (*Z. ang. Chem.*, 1904) definitely states that the blue coloration in zinc muffles or retorts is due to reduction of titanium dioxide, but gives no authority or special reason for his statement. Possibly he may have had the above-mentioned observation of Kersten in his mind, and assumed that the titanium compound must be present. The only difficulty in connection with this explanation is that Schulze and Stelzner failed to detect the presence of titanium in the German material, and Mühlhäuser asserted that mere traces of titanium are present in St. Louis clay. In a recent paper Mühlhäuser (*Z.ang. Chem.*, 1919) quotes Brandhorst's dictum, apparently with full acceptance, so that he may perhaps have found indications of large quantities of titanium later. Verneuil suggested that the tint of the sapphire is due to the same substance (*Chem. Ztg.*, 1910).

The brief allusions to zinc slags may be supplemented by a few observations from a recent article by Mühlhäuser (***Metall und Erz.*** 1918). Though not formed in great quantities, these slags constitute a troublesome by-product which often damages the body of the retort. With other metals the production of slag is deliberately aimed at, but in the case of zinc it is sought to avoid or limit the formation of slags, or at least to make them as harmless as possible so far as composition is concerned. In some operations carried out with a small trial furnace at the works of the Matthiessen and Hegeler Zinc Co. in La Salle, the roasted mixture of Joplin ore and Wisconsin ore used was composed of 86·96 ZnO, 0·36 CaO, 0·08 CuO, 0·37 PbO, 1·28 Fe_2O_3, 2·22 Al_2O_3, 0·80 CaO, 0·07 MgO, 7·00 SiO_2, 1·19 S, and must have consisted essentially of zinc oxide, silica, alumina, iron oxide and zinc ferrite, gypsum, zinc sulphide, and iron sulphide. After reduction of the roasted blende (50 lb. ore to 30 lb. anthracite) in the trial furnace, the residue had the average composition (for 19 operations) given in Table I.

The residue, consisting of the matrix of the ore, of partly consumed anthracite, and of the mineral ingredients of the latter, is probably composed of the following substances: the metals iron and copper, zinc oxide and alumina, iron silicate, $Al_2O_3.SiO_2$, $CaSiO_3$, Na_2SiO_3, and K_2SiO_3, sulphides of calcium, iron, and zinc, silica, and zinc spinel ($Al_2O_3.ZnO$). The components of the glowing ash bed are partly sintered, partly melted, and partly neither sintered nor melted. During the reduction process, and especially at the end of it, some of the silicates in the ashes become liquified and absorbed. With rise of temperature inside the muffle after removal of the zinc, fluid products will always be formed more freely because of the power which silicates possess of dissolving free silica as well as bases (protoxides and sesquioxides) and aluminates. A softened mass is thus formed adhering to the bottom of the muffle or retort, and this slag residue accumulates in time. In the case in question, it was carefully removed from the muffle after 135 days, and on analysis the slag was found to be composed as given in Table II.

The oxygen in bases to oxygen in silica is as 1:3. It is thus a trisilicate slag consisting chiefly of silica, alumina, ferrous oxide, and lime, with also a little zinc oxide.

The slags from the regular operation—charges of 54·8 lb. ore and 25·4 lb. anthracite per muffle, in the large reduction furnace—were found to have quite a similar composition as shown in Table III.

The oxygen in bases to oxygen in silica is as 1: 2·8, the slag being thus similar to that last referred to. Both slags were typical (as regards appearance, behaviour, etc.) of the regular operation slags at that period. The slag was mostly viscous at the temperature in the muffle, and formed an incrustation lining the inside of the vessel, more especially at the bottom. The skin of slag adhering to the bottom, or more or less merged in it, protects the underlying bottom from the corroding influence of other slag of different composition, checks diffusion, prevents or retards volatilization of metal, and so helps to increase the yield.

Examination of damaged vessels removed from the zinc furnaces showed that the accumulating slag had seldom seriously attacked the body of the distillation vessel, and only here and there was evidence noted of absorption of the slag by the wall in the lower half of the muffle. Similar action probably takes place, in the early period of use, with the porous bottom. Ferrous oxide, which is by far the most important of the fluxing materials in the ashes, forms with silica first fayalite, Fe_2SiO_4; this, on being absorbed by the muffle body, takes up from the latter more silica to form $FeSiO_3$, the melting point of which is 1,500°C., as compared with 1.155° to 1,075°C. for fayalite. Alumina is also dissolved, and such other bases as may be at hand, the product becoming more and more viscous until it finally solidifies. The material so formed is different in its properties from the original porous body, and is more liable to become cracked. It is also possible that ferrous sulphide (melting-point 1,194°C.) present in the charge may penetrate the muffle body in places, to be converted later into Fe_2O_3 and then into FeO or $FeSiO_3$.

Good slags are nearly or quite neutral towards the muffle, and can remain in contact with it for a long time without injuring it.

The formation of a glaze or glassy coating on the outside of muffles—from the action of dust and fumes—does not prevent the entrance of furnace gases, or the exit of reducing gases or zinc vapour, but it materially retards such movements, and therefore diminishes the formation of zinc dust while helping to increase the

TABLE I.

	ZnO %	CdO %	CuO %	PbO %	Fe_2O_3 %	Al_2O_3 %	CaO %	MgO %	SiO_2 %	K_2O %	Na_2O %	S %	C %
Soluble in acid	5·18	traces	0·30	0·10	8·40	1·60	0·24	0·08	—	—	—	—	—
Insoluble in acid	0·76	—	—	—	0·96	3·36	0·02	0·02	19·36	—	—	—	—
Total	5·94	traces	0·30	0·10	9·36	4·96	0·26	0·10	19·36	0·23	0·30	2·88	58·82

TABLE II.

	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	K_2O %	Na_2O %	CuO %	PbO %	ZnO %
Soluble in acid	0·52	5·21	7·63	1·94	0·19	—	—	0·06	traces	1·60
Insoluble in acid	66·42	8·45	3·49	2·40	1·11	—	—	0·10	—	1·82
Total	66·94	13·66	11·12	4·34	1·30	0·52	0·48	0·16	—	3·42

TABLE III.

	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	K_2O %	Na_2O %	CuO %	PbO %	ZnO %	S %
Soluble in acid	0·00	2·72	4·92	1·08	0.00	—	—	0·06	—	1·32	—
Insoluble in acid	65·12	14·14	3·00	5·94	0·65	—	—	0·04	—	1·32	—
Total	65·12	16·86	7·92	7·02	0·65	0·29	0·42	0·10	—	2·64	0·98

yield. (Mühlhäuser, *Metall und Erz*. 1918). The rate of action depends on the extent of the slagged surface of the muffle, on the thickness of the glassy layer, and on the degree of viscosity of the latter.

The rate of formation of the glaze depends much on the position of the muffle in the furnace and on the nature of the dust, and may be assisted by the white fumes of burning zinc. In the front of the furnace (where the producer gas enters) the muffles are more quickly covered than further behind. Dust is mostly deposited continuously on the rough surfaces of new muffles, and of those already covered with a viscous layer. Increase of the glaze is to some extent regulated by a trickling down when it softens by overheating, and the excess may thus drip in succession from one vessel to another below it, and finally fall on the sand-covered bottom of the furnace.

The glaze after cooling is mostly black owing to the soot present, but sometimes it has a greenish or brownish tinge according to the character of the furnace atmosphere at the time the muffle was removed. But wholly brown muffles were seldom seen at La Salle.

The following analyses show the composition of a dust such as formed a glaze on the body of a muffle, (1) before and (2) after its entrance into the zinc furnace, (3) the composition of the muffle body and (4) the composition of the glaze itself (with 8·85% FeO instead of Fe_2O_3.):

	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	K_2O %	Na_2O %	ZnO %	PbO %	C and S %
1.	11·99	3·01	5·16	0·46	0·06	0·34	0·44	—	—	rest
2.	13·10	4·66	7·44	0·24	0·02	0·48	0·52	30·04	0·78	rest
3.	44·68	32·52	3·60	0·10	0·00	0·11	0·20	19·10	—	1·29S
4.	50·26	31·84	8·85 (FeO)	1·40	0·36	1·09	1·68	3·20	0·28	1·04C

The oxygen ratio of acid to base was 2 : 1, so that it was a bisilicate. The formula was : 0·519 FeO, 0·106 CaO, 0·039 MgO, 0·049 K_2O, 0·114 Na_2O, 0·006 PbO, 0·167 ZnO, 3 544 SiO_2, 1·321 Al_2O_3, 0·366C.

Another glaze gave on analysis: 54·98 SiO_2, 32·78 Al_2O_3, 5·47 FeO, 1·96 CaO, 0 64 MgO, 0·51 K_2O, 1·81 Na_2O, 0·04 PbO, 0·22 ZnO, 1·59 C., corresponding to the formula: 0·461 FeO, 0·213 CaO, 0·098 MgO, 0·034 K_2O, 0·177 Na_2O, 0·001 PbO, 0·016 ZnO, 5·570 SiO_2, 1·954 Al_2O_3, 0·805 C. The oxygen ratio between acid and base was 1·602 : 1, indicating a sesquisilicate.

The analysis of a glaze which had formed gradually about the centre of the middle wall of a large zinc furnace may be of interest:

	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	K_2O %	Na_2O %	ZnO %
St. Louis clay (calcined)	56·08	39·26	3·09	0·78	0·51	0·07	0·19	—
Grog (7 years in the fire)	55·96	39·49	2·02	0·97	0·39	0·06	0·05	1·07
Glaze (on bricks)...	54·31	36·50	2·22	0·79	0·35	2·92	1·76	0·99

The 2·22% of Fe_2O_3 in the glaze represents 2·00% of FeO. The oxygen ratio between base and acid was 1 : 1·516, indicating a sesquisilicate. The formula of the glaze was: 0·183 FeO, 0·122 CaO, 0·078 MgO, 0·269 K_2O, 0·244 Na_2O, 0·104 ZnO, 7·869 SiO_2, 3·078 Al_2O_3. This glaze was fusible with difficulty, and did not penetrate further into the body, but just like the muffle glazes it was liable to become mobile and flow away when the temperature of the furnace was accidentally raised.

In choosing the heating arrangements for a zinc furnace, due regard should be paid to the advantageous influence on the yield of zinc, of the glaze coating on the outside of the distillation vessels. When firing with coal is adopted, and a coal rich in iron is available, a suitable producer should be placed in convenient proximity to the zinc furnace, so that the vessels may be exposed to sufficient dusting with the ash. From this point of view, natural gas and Mond gas—in spite of advantages due to homogeneous composition of the gas and the possibility of uniform heating—are by no means ideal combustibles, because they carry no dust with them. When such gases are employed for firing zinc furnaces it is desirable to remedy the deficiency by special glazing of the muffles, which, though not an easy problem, should not be impossible of solution.

The colour of the glaze of a zinc muffle is in the back part of a zinc furnace (where the gases have already become mixed uniformly) black, grey, green, or brown. In other places different parts of the surface may have the different colours, as grey, green, brown.

The glaze covering the blue body is green, like every muffle influenced by a reducing flame. When much soot is present in the flame the glaze is black; when zinc vapour, escaping through a crack or hole in a neighbouring muffle, burns to zinc oxide, a green or milk-white glaze is formed; when the green surface of the muffle was exposed to a transient oxidizing flame the glaze became brownish, or wholly brown with longer action of such a flame. Very rarely the glaze is nearly colourless and transparent, and appears blue because of the blue body which it covers. (Mühlhäuser, *Z. ang. Chem*. 1919).

The tempering (preheating or annealing) of zinc muffles before introducing them into the zinc furnace needs careful attention. The body is least sensitive to sudden cooling or heating when the constitutional water of the clay has been expelled, but without melting any of the fluxing material present in the body of the muffle. This is because the components of the body are still in practically the same unconstrained state as they were in just after the drying contraction, and the binding material (of the St. Louis clay in this case) has not yet begun to shrink. With overheating, sintering would set in, and the whole or parts of the vessel would begin to shrink, and the resulting strains would be liable to cause cracking and dislocation when temperature changes occurred. It is therefore important to avoid both total and local overheating as far as possible, in order to escape serious risks. (Mühlhäuser, *Metall und Erz*, 1918).

The tempering furnace is set while still very hot (over 100°C.), and after being closed up the contained muffles (or retorts) are left to themselves about 15 hours. Then a small fire is kindled, and the heat is increased very gradually so that in 24 hours or so the temperature reaches about 800°C., at which it should then be maintained until the muffles are taken out. The actual time of tempering is about 24 hours, the muffles being altogether about 40 hours in the furnace.

The gases about the muffles also diffuse into the bodies of the muffles, and reduction or oxidation actions take place according as combustible gases (CO, H, ammonia, hydro-carbons) or oxygen are in excess Sulphur, H_2S, and SO_2 may in some circumstances exercise a sulphating action. Ferrous oxide in the muffle body takes up oxygen to form higher oxidation products, and these are in turn converted by the reducing gases into ferrous oxide or may even be reduced to metallic iron temporarily. The prevailing atmosphere during tempering is reducing, but oxidizing conditions sometimes arise.

The loss of constitutional water from clay takes place mostly between 375° and 666°C., and finishes at about 800° (Mühlhäuser, *Metall und Erz*, 1918).

Pyrite loses gradually more and more sulphur as the temperature rises, from 200°C. onwards, the maximum being reached at 700°C.; ferrous sulphide (FeS) or magnetic pyrites (Fe_7S_8) is formed, or mixtures of FeS with FeS_2 and Fe. The decomposition products remain solid, since their melting point is never reached in the tempering furnace; the decomposition will take place there at a somewhat higher temperature, the bulk of the pyrite crystals being in the muffle body. Besides FeS and Fe, the decomposition products of pyrite may contain FeO and Fe_2O_3. Above 290° and up to 500°C., oxidation of pyrites slowly produces Fe_2O_3 and SO_2 only. Beyond 500°C. the oxidation of the FeS_2 may be preceded by a cracking. Sulphur is first distilled off as such, and combines with oxygen to form SO_2. Then the FeS is completely burned or roasted. But this will not be normal in the tempering furnace.

The decomposition of substances like spathic iron, limonite, gypsum, etc., takes place at comparatively low temperatures. Quartz in the muffle body is subject to sudden increase of volume at 570°C., and the strains produced give rise to cracks, and can sometimes cause complete destruction. But generally the amount of quartz is small, and its effects are scarcely noticeable. As a result of the reaction very small spaces are produced between the grains.

The tempered muffle is a moderately hard stone body, consisting of alumina and silica with small quantities of other substances which later partly act as fluxing materials, and then increase the strength of the body. It is remarkably porous, and for the most part very small cracks, fissures, cavities, etc., form a connecting system of spaces spreading through the muffle body from inside to outside. This system of spaces is highly permeable, either hot or cold, for gases, and towards thinly fluid fluxes the body behaves like a capillary tube system.

The body is homogeneous, fairly dense, and reasonably strong, and endures the temperature prevailing in the zinc furnace (maximum 1,300°C.), and occasionally pointed flames (1,600°C.), as well as abrupt temperature changes, and it is also a fairly good conductor for heat.

The gradual vitrification of parts of the muffle walls (especially bottoms) decreased refractoriness and resistance to sudden changes of temperature, but increased the strength, elasticity, and extensibility, so that the average life of the muffle was 63 days. (Mühlhäuser, *Metall und Erz*, 1918).

In the brief reference in the previous paper to the possible advantage from coating the distillation vessels with zirconia, it should have been pointed out that the very small contraction of zirconia causes practical difficulties in connection with such applications. These would in all probability be overcome if it were practicable to apply a number of coatings in succession, each with a larger proportion of zirconia than its immediate predecessor, and finishing with zirconia alone. The best grades of natural zirconia should be good enough for such purpose, without any chemical treatment.

GLASS SANDS IN SOUTH AFRICA.

In the *South African Journal of Industries* for May and June, Dr. Percy A. Wagner writes on glass manufacture, dealing particularly with the present condition of the industry in South Africa and its prospects. We extract herewith parts referring to the local occurrence of glass sands. We have omitted those parts relating to sandstones and old sand-tailing dumps, and to the resources of alkali, lime, fluor-spar, manganese dioxide, fire-clay, and refractories.

No systematic work has hitherto been undertaken on South African sands suitable for glass-making, and the writer's investigations have been confined to such occurrences as are likely to be drawn upon in the near future. Enough, however, is by this time known to warrant the assertion that there is in the Union vast resources of sands suitable for the manufacture of all but the very finest grades of glassware, the production of which is not likely to be undertaken locally for many a year to come.

The deposit near Pienaarspoort, in the Magaliesberg, Transvaal, from which the Hatherley glass factory derives its supplies, will first be dealt with, as this is the only South African sand that has so far been successfully employed on a large scale for making glass. It is situated about 400 yards to the north-east of Pienaarspoort Siding, on the Pretoria-Delagoa Bay railway, by which it is traversed. The deposit appears to be of considerable extent, and bore-holes have proved the sand to be 90 ft. in thickness. Sections exposed in the main pit show from 1 ft. to 2 ft. of dark-grey sandy loam overlying the bed of glass sand, the maximum exposed thickness of which is 2 ft. 6 in. In some parts of the pit a layer of impure, brownish-grey sand intervenes between the sandy loam and the glass-sand. The latter is of pale yellowish white colour, except when traversed by plant rootlets, around which a concentration of reddish-brown ferruginous matter has taken place. It appears to be very uniform in character, though the composition probably varies somewhat from point to point. The following analyses may be taken to represent the best material:—

	Unwashed Sand.	Washed Sand.
	%	%
SiO_2	98·98	99·46
Al_2O_3	0·57	—
Fe_2O_3	0·10	0·08
CaO	None	—
MgO	Trace	—
Loss on Ignition	0·31	0·20

The results prove the sand to be fairly pure, the iron content being well within the limits prescribed for even the better grades of white glass.

Under the microscope, the sand is seen to be composed almost entirely of grains of quartz with very occasional turbid grains of felspar. Most of the grains are coated wholly or in part with thin films of ferruginous, clayey matter, which can be partly removed by washing the sand with water, and completely removed by treating it with hot hydrochloric acid. As regards the shape of the grains, there appears to be a close relationship between degree of rounding and diameter, the very fine particles being almost without exception angular, those of medium grain sub-angular, and the coarse particles fairly well rounded. Treatment of a representative sample of the sand with a solution of methylene iodide (sp. gr. 3·3) shows that it only contains 0·068% of heavy minerals, that is, minerals of sp. gr. greater than 3·3. This is below the average for ordinary glass sands. Magnetic particles constitute 28% of the concentrate. The remainder was found to be made up of a very interesting assemblage of minerals, including zircon, rutile, ilmenite, anatase, cyanite, and limonite. The ilmenite shows alteration to leucoxene. Zircon occurs in well formed prismatic crystals with pyramidal end terminations; also in rounded grains. With the exception of rutile, none of the other minerals exhibit idiomorphic outlines.

The mechanical analysis of this and the other samples of sand examined was carried out with a set of standard laboratory screens, kindly placed at the writer's disposal by Professor G. H. Stanley. In these screens the apertures, unfortunately, are in English units—5, 12, 20, etc., meshes to the inch—and a comparison with the metric scale adopted by Boswell cannot, therefore, be made, except in the case of the 12, 50, and 120 screens, which have apertures of approximately 1, 0·25, and 0·1 millimetres. There is no screen in the set with an aperture corresponding even approximately with 0·5 mm. The mechanical composition of the sand was found to be as follows:

Mesh	Aperture in Millimetres	%
+ 5	+ 2·54	0·01
— 5 + 12	— 2·54 + 1·056	0·02
— 12 + 20	— 1·056 + 0·635	1·60
— 20 + 30	— 0·635 + 0·424	8·37
— 30 + 50	— 0·424 + 0·254	41·71
— 50 + 60	— 0·254 + 0 211	13·29
— 60 + 80	— 0·211 + 0·157	9·00
— 80 + 120	— 0·157 + 0·107	16·91
— 120	— 0·107	12·00

It will be seen that sand grade, that is, particles falling within the limits 1·056 mm. and 0·107 mm., are 87·97% of the whole. (The limits adopted by Boswell are — 2 and + 0·1 mm.). The results of the analysis show that the sand is rather poorly graded, being much inferior in this respect to most European and American glass sands, and also inferior to the Zandfontein sand, to be presently referred to. The most striking feature in comparison with the Zandfontein sand is the large proportion of superfine sand which it contains. The Pienaarspoort sand could be greatly improved by coarse screening through a 20 mesh screen to remove particles less than 0·635 mm. diameter, followed by fine-screening through a 60 mesh screen to remove particles less than 0·211 mm. diameter. The screened and washed product would be well suited by virtue of its chemical and mineralogical composition to the manufacture of the better grades of white glassware. The suitability of the sand in its natural condition for bottle-making has been amply demonstrated. The deposit is accessible and conditions are favourable to cheap working. The unscreened sand could be delivered on rail at Pienaarspoort Station at 3s. per ton, and the screened product at about 6s. 6d. per ton.

There are extensive deposits of sand suitable for glass-making in the Moot Valley, the wide, flat-bottomed depression between the Magaliesberg and Daspoort ranges, north of Pretoria. They extend along the south side of the valley from the neighbourhood of Silverton as far west, at least, as the western boundary of the farm Zandfontein No. 93, and probably mark the position of outliers of Karroo sandstone. The most important deposits are on the farm Zandfontein, which is traversed from east to west by a sand belt some hundreds of yards in width, and at least two miles long. The sand is dug in shallow pits, being used for building purposes, and by the Pretoria Iron Mines, Limited, for making the pig-beds in which their iron is cast. There are several groups of sand-pits. The most easterly of these is situated 2½ miles to the west of the Daspoort Cement Factory, and about 500 yards north of the Daspoort range. Sections exposed in this and adjacent pits show a variable thickness of overburden, in the form of dark-grey sandy loam, which merges downward into greyish-white sand mottled and streaked with iron oxide or into yellow sand overlying a persistent layer of pale, greyish-white sand. The following sections may be taken as fairly representative:

	1.	2.	3.
Dark-grey sandy loam	3 ft. 0 in.	2 ft. 6 in.	3 ft. 0 in.
Greyish-white sand mottled and streaked with iron oxide	1 ft. 0 in.	—	1 ft. 0 in.
Yellow sand		3 ft. 6 in.	—
Pale, greyish-white sand	2 ft. 6 in.	2 ft. 6 in.	4 ft. 0 in.

(1) Section exposed in most easterly pit.
(2) Section exposed in pit about 300 yards to the west.
(3) Section exposed in most westerly of eastern group of pits.

The upper limit of the white sand was found in several instances to coincide approximately with the surface of the underground water-table. Its light colour and purity may thus be due to the leaching effect of the underground water percolating slowly toward the centre of the Moot Valley. In the deepest of the pits the white sand is seen to merge downward into a friable, even-grained white sandstone, and similar sandstone is said to have been struck in some of the other pits. The white sand appears to vary somewhat in quality. The purest material is that exposed in the most westerly of the eastern group of pits (section 3), where the layer is 4 ft. in thickness. A partial chemical analysis of a representative sample of pale, greyish-white sand from this pit, carried out by Dr. B. de C. Marchand, showed: SiO_2 99·37%, Fe_2O_3 0·31%.

The microscopic examination of the sand proves it to be composed almost exclusively of grains of quartz. Many of these are completely coated with films of ferruginous, clayey matter, and few are quite free from iron stains. Sub-angular grains make up the bulk of the sand, but many of the larger grains are exceedingly well rounded. It is remarkably free from heavy minerals, only containing 0·081% of particles of specific gravity greater than 3·3. Magnetic particles make up 45% of the concentrate, and small, well-formed zircon crystals about 5% of the non-magnetic portion. The latter also contains small grains and crystals of rutile and irregular grains of ilmenite, leucoxene, and limonite.

A grading analysis of the sand gave the following result:

Mesh	Aperture in Millimetres	%
+ 5	+ 2·54	0·00
— 5 + 12	— 2·54 + 1·056	0·04
— 12 + 20	— 1·056 + 0·635	0·755
— 20 + 30	— 0·635 + 0·424	14·11
— 30 + 50	— 0·424 + 0·254	57·50
— 50 + 60	— 0 254 + 0·211	10 8
— 50 + 120	— 0·254 + 0·107	5·2
— 120	— 0·107	4·50

Sand grade, that is, particles falling within the limits 1·056 and 0·107 mm. diameter = 95·1%. The result shows the sand to be much better graded than the Pienaarspoort sand, 71·61% falling within the limits 0·635 and 0·254 mm., and 82·41% within the limits 0·635 and 0·211 mm. It is in this respect, however, still much inferior to the best European and American glass sands, and could be greatly improved by screening. The chemical, mineralogical, and mechanical composition of the sand proves it to be admirably adapted to the manufacture of white bottles and better-grade white glassware. With washing and screening, it would, in all likelihood, be good enough for plate glass. The sand exposed in the other pits, though not quite as pure, is probably equally well suited to the production of ordinary glassware.

The available reserves of sand on the farm Zandfontein must be enormous, and conditions are favourable to cheap exploitation. The sand is at present sold for building purposes at from 1s. 6d. to 2s. per wagon load of three tons. It could easily be delivered on rail at Hercules Station at 2s. 6d. per ton.

About a mile to the west of the Silverton Hotel, sand for building purposes has for many years been dug in shallow pits. The sand occurs in exactly the same position relative to the Daspoort range as that at Zandfontein, in a layer from 2 to 4 ft. in thickness, beneath a thickness of from 2 ft. to 2 ft. 6 in. of dark-grey sandy loam. It is of grey or yellow colour, with streaks and patches of brownish-red ferruginous matter, and while not nearly so pure or well-graded as the Zandfontein sand, is quite good enough for the manufacture of ordinary bottle glass.

At Kilnerton, about five miles to the east of Pretoria, and again in the same position relative to the faulted continuation of the Daspoort range as the Zandfontein sand, there is a fairly extensive deposit of pale-greyish sand, streaked with iron oxide. The sand layer, which has a maximum exposed thickness of about 3 ft., is overlain by 1 to 2 ft. of grey sandy loam. It is used for building purposes.

There are extensive deposits of greyish-white sand to the north and north-west of Wonderboom Poort, near Pretoria, that appear to be well suited for glass-making. A sample of washed sand from this locality was analysed in the laboratory of the Geological Survey, with the following result: SiO_2 99·5%, Fe_2O_3 0·09%, Loss on ignition 0·05%, total 99·64%.

There is a fairly extensive deposit of sand, suitable for bottle glass, on the farm Olifantsfontein, near Olifantsfontein Station, on the Pretoria-Johannesburg railway. A company, called the Elephant Glass Works Co., Ltd., was formed some years ago to erect a glass factory at this locality, but the project did not materialize.

There are great accumulations of fairly pure sand on the Orange Free State side of the Vaal River at Vereeniging. The best material, forming a layer 1 ft. 6 in. in thickness, analyses: SiO_2 98·0%, Fe_2O_3 0·3%. Sand of somewhat inferior quality, occurring in a layer with a maximum exposed thickness of 4 ft., analysed: SiO_2 95·5%, Fe_2O_3 1·55%.

There are similar deposits of sand lower down the Vaal River at Viljoen's Drift and other localities.

Sand suitable for bottle-making occurs in considerable quantity in the neighbourhood of Bronkhorstspruit, on the Pretoria-Delagoa Bay railway. It is rather variable in quality, as is clearly indicated by the following analyses of samples taken from four different localities:

	1.	2.	3.	4.
	%	%	%	%
SiO_2	94·4	96·2	93·0	92·8
Fe_2O_3	1·6	0·8	0·8	1·3

At the Tweefontein Colliery, near Witbank, a belt of sand, 80 yards wide, has been proved over a distance of about a mile. Sections exposed in a sandpit adjoining the colliery show:

Sandy soil with grass roots	1 ft. to 1 ft. 3 in.
Yellow sand mixed with oxide of iron	2 ft.
Fine white sand	1 ft. 2 in.
Clayey sand with oxide of iron	2 ft. 7 in.

The white sand was examined with a view to determining its suitability for glass-making. It is of almost pure white colour, being superior in this respect to any other South African sand that has come under the writer's observation. On strong ignition it reddens slightly. Under the microscope the sand, which is very fine-grained, is seen to be composed for the most part of sub-angular grains of quartz, though many of the finer particles are quite angular. Most of the grains have a thin coating of ferruginous clayey matter. Heavy minerals of specific gravity greater than 3·3 make up 0·016% of the whole. Among them minute crystals of zircon and grains of magnetite are fairly common. A partial chemical analysis of the sand by Dr. J. McCrae showed: SiO_2 99·26%, Fe_2O_3 0·23%, Al_2O_3 0·28%, CaO and MgO traces, loss on ignition 0·23%. It is thus of great purity. With washing it would probably yield a product containing well below 0·1% of iron oxide.

The mechanical analysis of the sand gave the following result:

Mesh	Aperture in Millimetres	%
+ 5	+ 2·54	*1·00
— 5 + 12	— 2·54 + 1·056	0·50
— 12 + 16	— 1·056 + 0·795	1·70
— 16 + 20	— 0·795 + 0·635	2·30
— 20 + 30	— 0·635 + 0·424	9·00
— 30 + 50	— 0·424 + 0·254	23·50
— 50 + 80	— 0·254 + 0·157	29·50
— 80 + 120	— 0·157 + 0·107	13·00
— 120 + 200	— 0·107 + 0·063	7·00
— 200	+ 0·063	12·00

*The particles belonging to this grade were mostly of the nature of small concessions.

Sand grade, that is, particles falling within the limits 1·056 and 0·107 mm. = 79·50%. The results prove the sand to be much finer grained even than the Pienaarspoort sand. The comparatively high proportion of superfine material would militate against its use in an unscreened condition. If it were coarse-screened through a 30 mesh screen to remove particles greater than 0·424 mm. diameter, and fine-screened through an 80 mesh screen to remove particles less than 0·157 mm. diameter, the resulting product would be eminently suited to the manufacture of the better grades of white glassware. It would take approximately two tons of unscreened sand to produce one ton of screened, but as conditions are favourable to cheap working the screened product could probably be delivered on rail at 6s. per ton.

The Union Glass Company proposes, in their new bottle factory to be erected near Dundee, Natal, to use river sand occurring in the form of low terraces and banks in the bed of the Sandspruit, a tributary of the Buffalo River, about ¾ mile south-east of the Malonjeni Station, on the Vryheid railway. The company has secured rights over a stretch of about two miles of the river-bed, which is from 100 to 200 ft. in width. The available reserve of sand within this stretch is practically inexhaustible, as it is replenished each rainy season. The sand is of brownish-yellow colour. It contains pebbles of sandstone, shale, and dolerite, and small concretions of calcareous and ferruginous matter. Another feature is the presence of numerous small fragments of coal derived from the colliery dumps within the basin of the stream. A partial chemical analysis of a representative sample of the sand, from which all coarse matter had been removed by putting it through a sieve with round holes of 2 mm. diameter, gave the following result: SiO_2 93·61%, Fe_2O_3 1·42%, Al_2O_3 (including small amounts of TiO_2 and P_2O_5) 2·20%. Under the microscope the sand is seen to be made up mainly of sub-angular grains of quartz, most of which are coated or stained with iron oxide. As might be expected of a river sand, it is comparatively rich in heavy minerals, among which grains of pink garnet predominate. Actually, the heavy crop, composed of particles of specific gravity greater than 3·3, amounts to 0·23%. Magnetic particles make up 17% of the concentrate, and grains of garnet about 25%. Other minerals identified include zircon, blood-red rutile, cyanite, staurolite, and ilmenite. The mechanical analysis of the sand was as follows:

Mesh	Aperture in Millimetres	%
+ 5	+ 2·54	0·1
— 5 + 12	— 2·54 + 1·056	2·0
— 12 + 16	— 1·056 + 0·792	1·0
— 16 + 20	— 0·792 + 0·635	21·1
— 20 + 50	— 0·635 + 0·254	69·4
— 50 + 120	— 0·254 + 0·107	5·0
— 120	— 0·107	0·8

Sand grade, that is, grains between the limits 1·056 and 0·107 mm. diameter = 97·1%. The analysis proves that, while the sand is much coarser than that from the neighbourhood of Pretoria, it is, from the point of view of the glassmaker, better graded than either the Pienaarspoort or the Zandfontein sand. If it were put through a standard 20 mesh screen, and the portion remaining on the screen rejected, there would be obtained a product composed to the extent of 99·2% of particles ranging from 0·635 to 0·107 mm. diameter, and eminently adapted, both as regards chemical and mineralogical composition, to the purpose for which it is intended, namely, the manufacture of dark bottle glass. Burning to remove particles of coal and organic matter would still further improve it.

The Union Glass Company is at present employing coarse yellow sand found on the slopes of Talana Hill, Natal, which adjoins the factory site. The sand is derived from a thick bed of sandstone cropping out on the side of the hill. A partial chemical analysis of the sand showed: SiO_2 95·5%, Fe_2O_3 1·2%. The sand contains a good deal of fine coal and small concretions of iron oxide. To eliminate the coal it is burned in a small, gas-fired roasting furnace. Under the microscope it is found to be composed principally of sub-angular and angular grains of quartz, almost without exception coated with films of ferruginous matter. It contains 0·18% of particles of specific gravity greater than 3·3. Magnetic particles make up 19% of the concentrate. The non-magnetic portion is fairly rich in crystals and grains of rutile. Other minerals present include zircon, garnet, ilmenite, and cyanite. The mechanical analysis of the sand was as follows:

Mesh	Aperture in Millimetres	%
+ 5	+ 2·54	2·1
− 5 + 12	− 2·54 + 1·056	8·0
− 12 + 16	− 1·056 + 0·792	9·0
− 16 + 20	− 0·792 + 0·635	11·0
− 20 + 50	− 0·635 + 0·254	46·0
− 50 + 120	− 0·254 + 0·107	20·0
− 120	− 0·107	3·5

Sand grade, that is, particles falling within the limits 1·056 and 0·107 mm. diameter = 86·4%. The results prove that the sand is coarser than the Malonjeni sand, and not nearly so well graded. Like the Malonjeni sand, it could be greatly improved, as regards grade, by putting it through a screen with 20 holes to the linear inch.

As regards other occurrences in Natal, pure white sand is said to be available at Sweetwaters, near Maritzburg, and at Gezubuso. Sand suitable for bottle glass occurs at Jacobs, just outside Durban.

Quartz sand, well adapted to the manufacture of glass, occurs in the south-western districts of the Cape Province in the beds of many of the rivers rising in the long southern and south-western mountain ranges.

White sand of greater or less purity occurs in vast quantity at many localities along the coast of the Cape Province and Natal. It has been proved at Durban and Glencairn to be well adapted to glass-making, but in most instances its remoteness from coal renders it valueless for this purpose.

GOLD DEPOSITS AT MATACHEWAN, ONTARIO.

In our issue of August last year we quoted a report by A. G. Burrows, of the Ontario Geological Survey, on the gold discoveries near Fort Matachewan, on the Montreal River, where the results at the Otisse and Davidson claims have attracted considerable attention. Since then, H. C. Cooke, of the Geological Survey of Canada, has made a geological examination, and his report is printed in *Economic Geology* for June. We reproduce a large part of the report here, because the district promises to be an important producer.

The gold of Matachewan district was originally part of a granite or quartz syenite-porphyry magma. As the magma crystallized the gold became concentrated in the still liquid volatile residue, and was finally deposited from it along with pyrite. Consequently the gold is found in satellitic intrusive bodies which range from dykes of granite porphyry through pegmatites of varying degrees of silicification to veins of pure quartz. It is also found in the country rock adjacent to the dykes and veins, which has been calcitized and pyritized for considerable distances from their walls.

The geology of the district is similar to that of Timiskaming district in general. At the base of the geologic column lies the series of rhyolites, andesites, and basalts, with tuffs of corresponding compositions, which have commonly been referred to in the literature as Keewatin. The rocks are in most cases greatly altered, and the original constituents more or less completely converted into secondary minerals such as chlorite, hornblende, kaolin, sericite, and epidote; in places also the rocks have been converted into schists. These lavas are not overlain by sediments as in some places in Northern Ontario. After the deposition of the sediments an intense regional folding compressed sediments and lavas into close folds, and converted great portions of them into schists. Following the folding came the intrusion of great batholiths of granite and syenite. The syenite porphyry of Matachewan district is one of these intrusions; its magmatic relationships to large bodies of quartz syenite lying to the south and west are shown by close similarities in chemical and mineralogical composition. Both the syenite and the porphyry are cut by large dykes of a rather fresh-looking gabbro characterized in places by a great development of large plagioclases, which have attained diameters of several inches. After the granitic and other intrusions, a long period of erosion occurred, and the region was reduced to a peneplain of about the same contour as at present, on the surface of which the Cobalt series was laid down. This series, which is largely of sub-aërial origin, is the probable equivalent of the Middle Huronian of the south shore of Lake Superior. Later, probably in Keweenawan time, great intrusions of the Nipissing diabase took place, forming sills in the Huronian and dykes in the underlying rocks. These intrusions were the source of the silver ores of Cobalt and Gowganda, and the copper-nickel ores of the Sudbury district. Gentle folding movements followed the intrusion of the Nipissing diabase, throwing the beds into open folds with dips rarely exceeding 25°. The shearing and metamorphism characteristic of the older rocks is rarely found in the Cobalt series and the later diabase, which are commonly as fresh as if formed during the Tertiary.

The township of Powell is roughly divisible into two parts, the southern underlain by the Cobalt series, and the northern by the older volcanics. The gold deposits lie near the contact of the two series, between the east and west branches of the Montreal river. Their situation with respect to this contact is purely fortuitous and without significance as regards their origin. The contact is in a shallow valley occupied in part by a small stream called Davidson creek. The valley was the temporary channel, after the recession of the glaciers, of a much larger, rapid stream, the west branch of the Montreal river, which has left its traces in the form of large pot holes at two or three places.

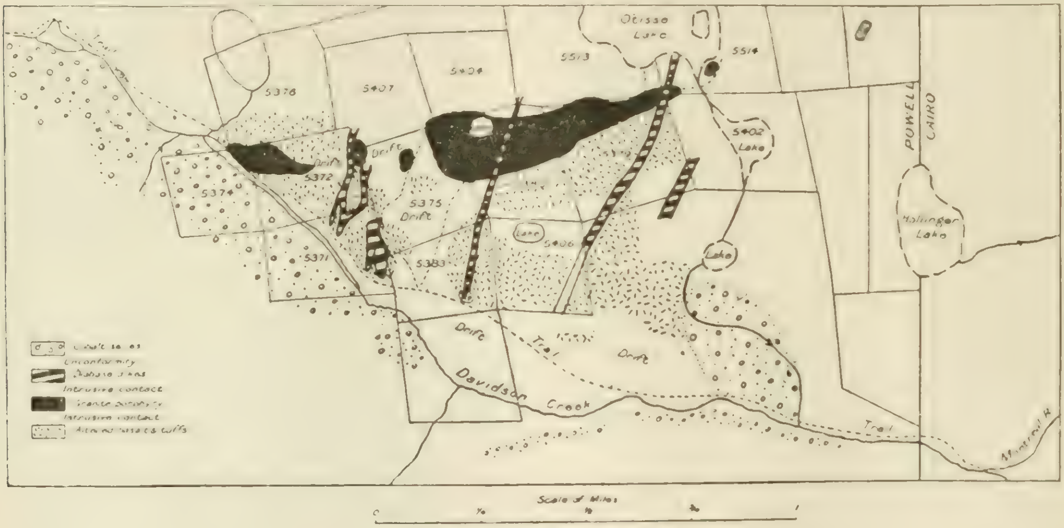
The old volcanics are cut by a series of intrusions of granite porphyry of varying size, and these are arranged along a fairly definite line striking N. 77° E. This direction is approximately parallel to the axes of the folding of the older rocks, and probably represents some zone of weakness developed during folding. It seems also probable that the exposed portions of the porphyry may be only projecting knobs of a much larger body beneath. The porphyries and older rocks are cut by many large dykes of the basalt of the pre-Cobalt age, some of which are indicated. The Davidson discoveries were made on the westernmost body of porphyry, the Otisse discoveries in the schist adjacent to the largest body of intrusive.

On the Davidson claims, Nos. 5371, 5372, 5374, 5375, and 5383, the ancient volcanics are greatly contorted and schistified, but have not been mineralized. Between the porphyry mass on claim 5372 and that on claim 5379 the schists are cut by many small dykes of porphyry, too small to show on the map, which indicate the unity of the two larger masses. On the Colorado-Ontario or Otisse, claims, Nos. 5379, 5380, and 5402, the volcanics, though closely folded, are not greatly contorted and but locally schistified. In the neighbourhood of the mass of intrusive porphyry they are cut by dykes of porphyry and pegmatite and enriched by solutions depositing auriferous pyrite. The porphyry mass on these claims is the largest yet discovered in the district, being somewhat over one-half mile in length and 500 to 600 ft. in width, On its north side, trenching has exposed on claim 5380 an ancient schistose conglomerate. Claim No. 5402 is as yet undeveloped, and as it is heavily drift-covered.

On the Davidson claims the ore-body is a portion of the porphyry itself. The porphyry is cut by a multitude of veinlets of auriferous quartz mostly less than one quarter inch in thickness, and spaced at intervals of approximately a foot. The porphyry has thus the character of a stockwork, although the veins in the main are not reticulating, but possess a sub-parallel arrangement evidently the result of jointing according to a definite system. Such jointing and enrichment has taken place mainly in the coarser-grained, more slowly crystallized phases, located, in general, toward the centre of the intrusive. Where the grain is finer, jointing and enrichment have not occurred. Channel samples taken along the bottoms of trenches in the enriched areas by the engineers examining the property are said to have yielded values varying from \$5 to \$25 per ton. The gold appears to be chiefly present as the native metal, although it is difficult to tell whether this was its original form, as development has not gone below the oxidized zone. However, the lack of limonite around many of the grains of gold would indicate that it is not residual from the oxidation of pyrite. Whether the pyrite also is auriferous has not as yet been established. The gold is found principally in the narrow veins of quartz that intersect the porphyry, but grains of gold have occasionally been found within the porphyry itself, although never more than a few inches from a veinlet. It is evident therefore that the gold was introduced by the solutions which also deposited the quartz

On the Colorado-Ontario, or Otisse, claims the porphyry has not been enriched as on the Davidson claims, so far as known at present, but a heavy cover of soil and swamp on it has hindered prospecting. Those portions which have been uncovered are jointed and veined only to a slight extent. The ore-bodies of this property are found in the schists surrounding the intrusive. Little is known as yet about the nature of the ore-bodies beyond what can be seen on the surface.

The schist ore-bodies are lenticular. While this has been proved in only two cases by the removal of the drift from the whole outcrop of the ore-body, the fact that ore-bodies crossed by a trench can rarely be picked up in a parallel trench 50 or 100 ft. distant, indicates a similar shape for these also. Drilling is at present being conducted with the object of testing the hypothesis that the lenticular outcrops are but the surface expression of ore-shoots which may have a considerable downward extension. The size of the ore-bodies varies greatly ; small bodies a few inches or feet in width are numerous, while the largest so far found is about 75 ft. in width. The large bodies lie with their long axes approximately parallel to the bedding planes of the tuffs, and may eventually prove to have some relation to the secondary folding. The position of the smallest bodies, those in general less than a foot in width, does not seem to have been controlled by the bedding, but by joint cracks, so that they lie in various positions.



THE MATACHEWAN GOLD AREA.

Close examination of the ore-bodies appears to justify the following conclusions: (1) The ore-bodies have been formed by solutions emanating from the dyke or vein at their centres. These solutions have altered and mineralized the country rocks. (2) The tuffs may have been more easily altered and mineralized than the altered basalts. (3) The extent of the mineralization and alteration are related to the size and the composition of the central dyke or vein. The strongest alterative and pyritizing effects have been exercised by the pegmatites, while the effects of the end members of the series, the porphyry dykes and the quartz veins, have been slight. The pegmatites containing 25—50% of felspar appear to have produced the most powerful mineralization and alteration. Other things being equal, the extent of alteration and mineralization is roughly proportional to the size of the dyke or vein. (4) The gold content of the dyke and vein-forming solutions was also dependent on their composition. The pyrite deposited by the dykes of red porphyry contains relatively little gold. Grey porphyry dykes carried more gold, sufficient to give a good tenor within the dykes themselves, but not, apparently, to mineralize the surrounding rocks to any great extent. Pegmatites appear to have carried the maximum of gold, which they deposited as auriferous pyrite both in the veins and in the altered wall-rocks; while the solutions forming the pure quartz veins carried little gold.

The only primary ore mineral present appears to be auriferous pyrite; however, a detailed study of the ores by the aid of the reflecting microscope has not as yet been made. If ore minerals other than pyrite are present, they are in minor amount. The gold occurs only in the pyrite, in what form is not known. Native gold is not found, except in oxidized surface portions. In general a high pyrite content indicates a correspondingly high gold value, although in one or two places this has not proved true. In the pegmatites the pyrite is coarse-grained in crystals and aggregates several mm. in diameter; but in the adjacent schists the pyrite is always fine-grained, 0·3—0·5 mm. in diameter of crystal. Only in one case was this not found to hold good. In this instance the pyrite is very coarse-grained.

Mr. Cooke's summary and conclusions are as follows: (1) The internal structure of the ore-bodies, consisting of a pegmatite vein at the centre, a middle zone of mineralized and altered rock, on each side, and an outer zone of altered rock without mineralization, which grades into unaltered country rock with irregular and embayed contacts, is clear evidence that the deposits in schist have been formed by the alteration and mineralization of the country rock by solutions coming up along the central vein. The partial calcitization of the felspar of the pegmatite indicates a change in the character of the solutions during the formation of the ore-bodies.

(2) The serial composition of the various veins of pegmatite, varying from veins of pure quartz up through pegmatites of increasing felspar content, to dykes of pure porphyry, indicates an igneous origin for all.

(3) The satellitic arrangement of the veins, in that with few exceptions they are grouped within an area bounded by a line drawn about 1,000 ft. from the edge of the porphyry mass, with the major number within 500 ft., points conclusively to their genetic connection with the porphyry intrusive.

(4) Veins or dykes approaching the porphyry in composition, deposited little or no gold, but did in places deposit pyrite. They had no strong alterative action on the wall-rocks. Pegmatites deposited auriferous pyrite, and had a powerful alterative action on the wall-rocks. Quartz veins had little action on the wall-rocks, and deposited little or no pyrite. Other things being equal a rough proportion exists between the size of the vein and the size of the altered zone around it.

(5) It is concluded, therefore, that the schist ores of the Matachewan district were deposited by juvenile solutions originating as the last products of the differentiation of masses of intrusive granite porphyry. The solutions were at first rich in silica, soda, and alumina, which crystallized out first to form the material of pegmatite veins. The separation of these constituents left the solutions relatively enriched in lime, carbon dioxide, iron, sulphur, potash, and gold, and their reactions with the wall-rocks caused the formation of replacement deposits whose principal minerals are calcite and auriferous pyrite.

(6) There is little direct evidence to connect the gold of the Davidson property with the porphyry, except the fact that the veins are confined within the intrusive mass. However, the proof that the neighbouring stock, which is petrographically identical with the Davidson porphyry, carried gold, renders the conclusion inevitable that the gold of the Davidson property was also a magmatic constituent. The differentiation has here continued uninterrupted to the stage in which the mineral constituents of the magmatic solutions are silica and gold, and these are deposited as quartz with native gold.

THE BROKEN HILL EXTENSION.

In our issue of June last, we quoted F. Danvers Power's account of the theory of the brothers Marshall with regard to the continuance of the Broken Hill lodes and the work done, or to be done, in the outlying parts of the district. The *Industrial Australian & Mining Standard* for May 29 reprints an article which appeared in the Adelaide *Register*, giving further information. This we reproduce herewith.

Twenty-five years ago, the Broken Hill mining field became depressed when the carbonate ore gave way to sulphides. But the sulphide problem was solved. More recently the mines were faced with a zinc problem. That difficulty also was solved. To-day some of the mines are threatened with a shortage of ore. These are promised a new life if the new Marshall geological theory is proved correct. It is only a few years back that pessimists predicted but a brief life for the Broken Hill line of lode, and diminishing ore-bodies were spoken of gloomily, yet the South, North, British, Central, and South Blocks have opened up huge bodies of sulphides at depth, and are still developing with excellent results. The field, as a result of these developments, has visibly a longer life directly before it than at any stage of its existence; and if the Marshall theory be correct this life will be accentuated many times over. Geologists have always, in dealing with the Broken Hill line of lode, held to the saddleback theory, with the seat of the saddle at Block 14 mine. The ore-body, they have argued, has pitched therefore N and S, deepening the farther it gets away from the seat. The Marshall theory is that the main lode comprises a series of ore-bodies at one time more or less horizontal, which have been lifted to the surface, possibly by volcanic or igneous action, forming synclinal troughs, doming at various points with intermediate basins. Allowing that one dome is at Block 14, the theorists claim that another is at Round Hill, a third at Piesse's Nob to the N, and a fourth near the old Rising Sun to the S. In the basins the ore-bodies, it is asserted, even though possibly broken to dip E and W, form parallel lenses. The brothers Alexander and Allen Marshall, who, with Ernest V. Jones, have given the ore occurrences of Broken Hill many years of study, have great faith in the synclinal theory, and have apparently found many city investors and speculators to share their faith

Long stretches of ground N and S of the group of mines comprising what is known as the main line of lode have been taken up on lease, and to-day there is a direct run of mineral propositions extending from the Pinnacles on the south to the Piesse's Nob on the north. The series has a length of 14 miles, from which about three miles may be subtracted for the main line of lode. A considerable area of this 11 miles of country has already been formed into working and developing companies, while the other companies are in process of formation. Close on £300,000 capital is already or is about to be involved in these mineral propositions. It has taken the Marshalls and those associated with them close on two years to put their scheme on its present basis, but they are now in a position to make known what has been done. So far, of course, work has been confined to development, extending on some blocks what was done in the past, and on others opening up and testing virgin ground. Considerable carbonate and sulphide ore has been won in development on Marshall's Caledonian Mine, once known as the White Leads. Some of this ore has been sold. An initial plant to treat the carbonates and prepare them to the requisite selling grade is now in process of erection. Underground it has been blocked out to the 300 level, but the Marshalls do not expect their theory to be fully tested until the 600 level is reached. Marshall's Monarch, at the Pinnacles, is also producing in development. Diamond-drilling will be adopted here and on the Village Blocks adjoining. Active work is in progress on the Round Hill, which property comprises ten blocks of the freehold held by the old company and five of Marshall's leases. Here the main work is being done in the old Chloride shaft, where the lode has been struck in two places between the 100 and 200 levels going west. Those interested in the Round Hill proposition include some experienced mining and business men, such as William Jamieson, Colin Templeton, L. Mackinnon, Alfred D. Hart, and others.

The companies formed and forming in connection with the Marshall's scheme are Marshall's Caledonian, capital £25,000, Sydney; Broken Hill Extended £5,000, Sydney; Rising Sun £25,000, Sydney; Young Australia £25,000, Sydney; Block 10 (Marshall's) £50,000, Melbourne; group adjoining (unnamed) £25,000, Sydney; Imperial, Cosgrove and Crescent group (under negotiation with Broken Hill Proprietary Co.); Round Hill Silver Mining Co. £13,000, Melbourne; Broken Hill Consolidated £25,000, Sydney; Barnes Freehold £12,000, Sydney; Broken Hill Options £20,000, Sydney; Broken Hill Extended £5,000, Sydney; Broken Hill Block 196, £5,000, Sydney; Broken Hill (Alma) Extension £5,000, Sydney; Eastern Pinnacles £5,000, Sydney; Village Blocks £20,000, Sydney; Marshall's Monarch £5,000 Sydney. Broken Hill Options is in one respect the father of the Marshall proposition. It is an exploratory-development concern. It is not a producing company, though its object is to promote mines that will produce. It has, for instance, taken up most of the Marshall blocks, and has been instrumental in forming them into working companies. The Caledonian and Round Hill are particular instances. Much money has been spent on the Caledonian as the White Leads, but the leases were lying dormant. So with many other blocks, but more particularly with Round Hill property. Much of the success or failure of the Marshall theory depends on Round Hill. The theorists claim that the ore is in the hill, but has not been searched for properly. They assert that following out their theory, they can find it. Upon the success of this assertion depends more or less the fate of leases farther north. The past has proved the existence of ore in the Consolidated and Globe, but never in sufficiently payable quantities. A good test of the Consolidated was made by young Mr. Delprat, but the controlling company had not the money to sink deep. G. D. Delprat always professed faith in the property, but expressed the opinion that the payable ore-body would not be met with above 1,200 ft. The Marshalls think they can pick it up much higher. The Globe, a freehold property, has been tried once since the carbonate days, but the expenditure on it was not then justified. Since the company ended work, tributers have been doing fairly well on veins of high grade ore. The Marshalls had an option over the Globe, which is directly in their run of property, but for financial reasons have relinquished the option to another Sydney party.

Broken Hill Options has at present fourteen blocks along the northern extension, which have been given under working option to four companies, each of which has undertaken to form one or more working companies of not less than £10,000 working capital each. In each of the companies to be formed Broken Hill Options will receive half whatever interest the promoting company obtains. These companies are the Broken Hill Extended Silver and Lead Mines, Broken Hill Block 196, Broken Hill (Alma) Extension, and Eastern Pinnacles. These companies had blocks, at the south end of the field, of White Leads (Caledonian), but transferred their interest to the north end, north of the Globe. Here also are Sutton's Blocks, while nearer Round Hill are Barnes's, in all of which Broken Hill Options is concerned. In the vicinity also are the Cosgrove, Imperial, and Silver Crescent properties. The Broken Hill Proprietary Co. had the water rights over these leases, and the question of mining rights has been before the mining warden for decision. An amicable arrangement, however, has now been reached, and an amalgamation of interests will, it is expected, materially assist the flotation. There has been another amalgamation at the south end of the field, between Broken Hill South Extended and the Block 10 Company. Here several blocks held by Block 10 near the Rising Sun have been pooled with others taken up by the Marshalls, and a company has been formed in Melbourne. Delay in commencing work has been caused by the Federal Treasurer objecting to the capital as too large. This, however, has been reduced, and the company is about to be registered. The blocks will be worked under Block 10 management. An amalgamation between Marshall's Monarch and the Village Blocks, at the Pinnacles, has also been suggested.

The Marshall scheme, taken in its entirety, is a gigantic one. All the blocks in it will be worked more or less on the one big plan to test the new geological theory. This naturally will not be done in a day, but will take much development to achieve. Meantime, employment is being given to a large number of men. The scheme has got beyond its initial stages, even though still in its preliminary stage.

[Further reference to the Marshall theory is made in this issue, in the News Letters and in the editorial columns respectively. In the latter case the remarks are accompanied by an outline map of the district.—EDITOR.]

Ventilation Problems at City Deep.—At the meeting of the Midland Institute of Mining, Civil, and Mechanical Engineers, held at Sheffield on July 24, a communication was read from E. H. Clifford, consulting engineer to the Rand Mines, Limited, giving particulars of the problem at City Deep. We quote Mr. Clifford's notes herewith.

The structure of the City Deep mine is simple. The area is roughly rectangular, about 12,000 ft. long on the strike and 8,000 ft. on the dip. The reef along the northern boundary, which is the shallowest, lies at a depth of slightly more than 2,000 ft., and at the southern boundary the depth reaches about 7,000 ft., the dip averaging between 35° and 40°. The width of the workings in the stopes is about 5 ft. The mine is operated by two rectangular timbered shafts about 4,000 ft. deep, and 4,000 ft. apart. There is also near the northern boundary a ventilating shaft, 20 ft. diameter, and equipped with a Sirocco double-inlet fan of 400,000 cu. ft. per minute capacity. The two rectangular shafts are downcast. In addition, a new shaft is now being sunk near the southern boundary, designed to reach a depth of 7,000 ft. It is 20 ft. in diameter, and will be used as a main winding and downcast shaft. At the present time the workings, which are confined to the uppermost portion of the mine, extend over an area of approximately 10,000 ft. along the strike by 3,500 ft. on the dip, and the greatest vertical depth at present is 4,500 ft. On the Witwatersrand the temperature of the rocks increases at the rate of 4° for every 1,000 ft. in depth, and the rock temperature at 4,500 ft. is 84°. This would not be at all serious were it not for the fact that the air, shortly after leaving the main intakes, very soon became saturated in consequence of regulations stipulating that all rock surfaces must be kept wet in order to prevent the dissemination of dust. A saturated air at a temperature of 84°F. is scarcely supportable unless the air is in active motion, and this latter condition cannot be maintained at every point, particularly in development ends. In this connection it may be mentioned that the katathermometer, designed by Dr. Leonard Hill, has been found most useful in translating the physiological temperature state of an atmosphere into a single numerical result, as this instrument not only takes into consideration the temperature and humidity, but also the cooling effect due to motion of the air.

The limit has been reached on the City Deep, and there is yet an additional 2,500 ft. to go. The engineers are faced with the necessity of reducing the air temperature from between 95 and 100°F., which it would be at 7,000 ft., to about 75°F. The principle that is being relied upon is the heat-absorbing capacity of the ventilating current of air due to evaporation and to its specific heat. Local cooling near the bottom of downcast shafts is, of course, taking place everywhere, but it generally remains local cooling only, and in any case can have little or no effect on the temperature of distant parts of the mine, unless the total heat absorbed by the air current as a whole is greater than the heat supplied from all sources. In the City Deep this latter condition obtains at the present moment, and there is not the slightest difficulty with temperatures down to a depth of 4,500 ft.; but whether the principle will be equally successful at 7,000 ft. remains to be seen. However, practical observations and careful inquiry into the physics of the problem render it quite probable that they would be successful. The air becomes warm after it has travelled some distance from the main intake, but, except in the case of long dead-ends, no difficulty has been found in keeping all the working places at a satisfactory temperature. Dead ends will have to be cooled by a special ventilating pipe supplying dry air to the face, but the necessity for this has not yet become urgent, as the air at the face, where nearly all the work is done, is effectively cooled by the exhaust from the rock-drills.

The heat of the air in the mine comes from the following sources: (1) The compression of the air in its way down the shaft. This is considerable; in fact, the temperature rise on this account is actually greater than the temperature rise of the rock due to depth. (2) The flow of heat from the rock mass to the air of the workings. This depends upon a great many factors, among them being (*a*) the conductivity of the rocks and the temperature difference between the rock and the air current; (*b*) the relation between the volume of the workings and the rock surface; and (*c*) the daily increment of surface resulting from mining. (3) Further sources of heat are water, the men working in the mine, the combustion of illuminants, explosives, and electric power. A frequent source of heat supply, namely, chemical change of minerals, is not, in the case of the Witwatersrand, of any importance.

To absorb this heat the engineers are relying upon: (1) The specific heat of the air, and (2) the heat absorbed by its evaporative power. It is fortunate that in the Transvaal the air during the greater part of the year is dry, the percentage of humidity ranging between 74% during the rainy season and about 36% during winter, and it is this fact that renders the method practicable, and might possibly afford a complete solution of the difficulty. The capacity of the fan is, as previously stated, 400,000 cu. ft. per minute, and the average heat-absorbing power of this quantity of air is 1,700,000 calories per second. Of this amount one-fifth is due to the specific heat of the air and four-fifths due to evaporation. On account of the dynamic heating, there is lost, in the deepest part of the mine, practically the whole of the heat-absorbing capacity resulting from the specific heat, but as the air rises to the shallower parts of the mine, some of this is returned. In the calculations the abstraction of 1,360,000 calories per second is all that is relied upon. The items under the heading (3) amount to about 185,000 calories per second, leaving a balance of roughly 1,200,000 calories per second available for absorbing the heat from the rocks. Assuming that the mine is bounded by an infinite mass of rock, and assuming that the estimate of conductivity, which is based on experiments, of 0·0093 is correct, this quantity of heat is greater than the heat-flow from the rocks to an air current of a temperature of 75°F. Under the present conditions, therefore, the mine would tend to become cooler as a whole, but the continuous increase in the extent of the mine is having the opposite tendency.

The process is self-regulating to a considerable extent, because the heating of the air increases its evaporative power, and there is abundant moisture everywhere for the exercise of this power, and also in consequence of the dynamic cooling as the air travels from the lower to the upper parts of the mine. It is important to keep the downcast shafts as dry as possible, in order to preserve as much evaporative capacity as possible for use in the distant parts of the mine. In practice, this leads to a little difficulty in controlling the temperature, as the air is apt to become too cold just after it leaves the main intake if there is an abundant supply of moisture, and, on the other hand, it becomes too hot where the current is sluggish. Control is generally effected without much difficulty in either case by regulating the quantity of the air and restricting the supply of moisture. The dynamic cooling admits of a very simple type of ventilating scheme All that is necessary, so far as the temperature is concerned, is to keep the downcast shafts dry and bring the main supply of fresh air to the deepest part of the mine. If its condition is made satisfactory at this point, it is not likely to become unsatisfactory higher up in the mine. A further effect of the dynamic fall in temperature is to bring about a condensation of moisture, making the air extremely foggy in the upper parts of the mine, and it has the incidental and unlooked-for advantage that the air becomes completely cleared of dust particles.

The New Elmore Process.—Following the main patent covering the new process invented by F. E. Elmore for treating lead-zinc sulphides quoted in the August issue of the Magazine, a further patent for methods of procedure has since been published. This is numbered 11,126 of 1918 (129,773). We give the following extracts : In such processes there is formed in the brine, as a result of the operation, a certain quantity of sodium sulphate, consequently, if the brine be used repeatedly an accumulation of sulphate and a loss of chloride occur, and eventually a notable falling off in the efficiency of the liquid is observed. Further, the lead salts produced contain lead sulphate and chloride in proportions which vary with the concentration and other conditions, and a product of this composition in some cases offers disadvantages from the metallurgical standpoint. One object of the present invention is to effect, in such processes, a removal of sodium sulphate from the used brine, whereby its efficiency is substantially restored. Another object is to convert the lead salts wholly into the sulphate, whereby the lead is obtained in a form more suitable for further metallurgical treatment. The invention may be carried out either before or after removal of the lead salts from the brine. In the latter case the invention broadly consists in (1) eliminating sodium sulphate from the used brine, after removal of the lead salts, by further cooling the liquid to about 0°C., thus causing the excess of sodium sulphate to crystallize out ; (2) separating the crystals from the brine and dissolving them in hot water ; and (3) with this solution, preferably boiling, treating the lead salts in suitable proportion, whereby the lead chloride which they contain is converted into sulphate, which is then separated from the solution. The brine, after removal of the crystals of sodium sulphate, is ready for re-use and may, if desired, be strengthened by the addition of a further quantity of sodium chloride, for instance, sodium chloride recovered as hereinafter described. In the treatment of the lead salts for conversion of the chloride into sulphate, the proportions to be used and other details depend upon the composition of the lead salts and sodium sulphate solution, and other conditions. If the lead salts and crystals of sodium sulphate after removal from the brine have both been washed substantially free from sodium chloride, it is sufficient, in order to obtain lead sulphate technically free from chloride, to use approximately the quantity of sulphate solution theoretically equivalent to the lead chloride present in the salts. If, however, the lead salts and sodium sulphate contain sodium chloride, a lead sulphate technically free from lead chloride may nevertheless be obtained if the sodium sulphate solution be added in suitable excess. The lead salts may be in a dried or drained condition, or in the state of a soft mush, when treated with the hot sulphate solution, and the materials should be agitated or otherwise brought into sufficient contact to promote the reaction.

The inventor prefers to carry out the treatment of the lead salts by steps, so that the conversion takes place progressively instead of in one operation, the lead salts and sulphate solution being passed through the plant in opposite directions. For example, a series of vessels may be employed for the treatment, the fresh sulphate solution being supplied to the first of these and the fresh lead salts to the last. This method ensures that the lead salts, after being progressively converted to a substantial extent in the last and intermediate vessels, receive their final treatment with a solution containing the maximum of sulphate and minimum of chloride, the sodium sulphate being largely in excess of the lead chloride still to be converted ; while on the other hand, the sodium sulphate, having been largely converted into chloride in the first and intermediate vessels, is finally treated with lead salts containing the maximum of chloride and minimum of sulphate. It is thus possible to obtain, as final products, even from lead salts and sodium sulphate crystals containing sodium chloride, on the one hand lead sulphate technically free from lead chloride and on the other a solution of sodium chloride suitable for addition, either directly or after concentration, to the purified brine. If the invention be carried out before removal of the lead salts from the brine, the process is modified by cooling the brine and salts to about 0°C., whereby there is obtained, on the one hand, purified brine ready for re-use as already described, and, on the other, a mixture of crystals of lead salts and sodium sulphate. The mixture, after removal from the liquid, is treated with hot, preferably boiling, water, whereby conversion of lead chloride into the sulphate and sodium sulphate into the chloride is effected. It will be understood that according to the composition of the mixture some adjustment of the proportions, for example by adding lead salts or sodium sulphate from other sources, may be required.

In some cases the lead salts contain an appreciable proportion of silver, derived from the ore, and a further object of the invention is to provide a method of concentrating and recovering this silver if desired in a form better fitted for metallurgical treatment. In carrying out this modification of the invention the lead salts, after separation from the brine, are boiled with sufficient water to dissolve substantially the whole of the lead chloride ; there are thus obtained a solution of lead chloride and a comparatively small, undissolved residue of lead sulphate containing practically the whole of the silver. The lead chloride, after separation from the argentiferous lead sulphate, is then treated with hot sodium sulphate solution for conversion into lead sulphate.

Tin in Tailing Water.—It is often supposed that tin losses may be due to tin passing away in the water from dressing plant, either in solution or in the state of colloid suspension. Two brief notes on this subject are published in the August *Bulletin* of the Institution of Mining and Metallurgy, written by Dr. J. C. Philip and H. R. Beringer respectively. We quote Mr. Beringer : A sample of half a gallon of Red River water, taken at a point about one-third to half a mile below the last effluent from the East Pool and Agar dressing floors, and presenting the usual appearance to the naked eye, took about four hours to settle to clear water. Two litres of this clear water, after passing a filter, were evaporated to dryness. The dry residue was then assayed for tin by the zinc vapour (Beringer) method, using an iodine solution capable of detecting the presence of one part of tin in 8,000,000 parts of water. The addition to the residue of one drop of this iodine solution gave a decided blue with the starch indicator, thus proving the absence of tin from solution in the Red River water. An accident having prevented the determination of the tin in the settled sediment from the above sample, the author gives the previous determination upon similar material from a sample taken lower down the stream. This sediment amounted to 2·827% of the weight of the water and it assayed 15·36 lb. of tin per ton. At this rate one short ton of water passing down the river would carry 0·434 lb. of tin in mechanical suspension. The result may be summarized as follows: 2,000,000 parts of water contained in suspension 434 parts of tin (cassiterite) and in solution less than 0·25 part of tin.

Properties of Tin.—A paper is contributed to the August *Bulletin* of the American Institute of Mining and Metallurgical Engineers by E. F. Northrup that gives some information relating to the properties of tin. The author writes from the point of view of the expert in pyrometry and the object of the communication is to draw attention to the value of pure tin as a pyrometric substance.

Tin in quantities sufficient for pyrometric purposes may be obtained at relatively low cost and in a state of high purity. The metal melts at 232°C. and, according to determinations made by Greenwood in 1909, does not begin to boil until a temperature of 2,270°C is reached. The writer can assert, from personal observations carefully made, that tin shows no tendency to boil at a temperature of 1,680°C. If Greenwood's observations are correct the temperature interval, 2,038°C., in which tin exists as a liquid under atmospheric pressure, exceeds that of any other substance. It has never been observed, as far as the writer is aware, that tin forms any chemical union, as carbide, with carbon at the highest temperatures at which it can exist as a liquid. It is quite certain from the writer's personal observation that tin heated in Acheson graphite to 1,680°C. remains chemically uncontaminated. Wires of pure tungsten do not dissolve in molten tin at temperatures at least as high as 1,680°C. Tungsten wires or rods may, therefore, be used as electrodes dipping into molten tin when required for measuring the resistance of the molten metal at very high temperatures. When tin is raised to a high temperature in a covered graphite container, the CO atmosphere that exists above its surface has a reducing action, which maintains this surface of mirror brightness. Incidentally, tin maintained molten in a crucible of Acheson graphite makes a most excellent bath into which may be inserted several pyrometers that are to be intercompared at the same temperature.

But the two properties of tin that, in its molten state, make it particularly valuable as a pyrometric substance, are the strictly linear character of the increase of a given volume in resistivity with increase in temperature and the decrease of a given volume in density with increase in temperature. The increase in the resistivity of tin in the molten state has been studied by the writer with very great care and he can assert positively that up to a temperature at least as high as 1,680°C., and very probably beyond this temperature, the resistivity of the metal increases linearly with increase in the temperature. The same can be asserted in regard to the decrease in the density with increase in temperature. When the coefficients have once been accurately determined then, assuming that suitable methods are available for accurately measuring either the resistivity of the tin or the expansion of a given volume of the tin, one can in the former case deduce the absolute temperature and in the latter case the change in the absolute temperature.

There is no more reason why one should go back to the volume expansion or increase in pressure of a given quantity of gas as a final standard of temperature than that one should go back to a pure element like tin as a final standard, provided the properties of this latter substance are related to temperature in a manner as simple as the former. It is now, at least in the writer's mind, quite as certain that the resistivity of a given volume of molten tin is related by a straight-line law to the absolute temperature as is the pressure of a given volume of gas. Gas thermometry, for practical reasons, ends at the melting temperature of palladium, 1,550°C., while there are no practical limitations to prevent the accurate determination of an absolute temperature by measuring the resistivity of a definite volume of tin when the temperature is at least as high as 1,680°C. and probably as high as the melting point of platinum.

SHORT NOTICES

Winding Engine.—The *Colliery Guardian* for August 22 quotes an article that appeared in *Annales des Mines de Belgique* describing a bi-conical winding drum employed at a Belgian coal mine.

Shot-firing.—The *Iron and Coal Trades Review* for August 1 contains a report of a paper by Professor George Knox, read before the South Wales Institute of Engineers, describing the Harries safety shot-firing appliance.

Shot-firing.—The *Colliery Guardian* for August 15 contains a translation of a paper by Taffanel, Dautriche, Durr, and Perrin, which appeared in *Annale des Mines* describing experiments in connection with shot-firing undertaken with a view of studying the causes of misfires.

Disposal of Waste.—The *Colliery Guardian* for August 8 describes an automatic tipping bucket for use in disposal of waste rock or tailing, made by the Blantyre Engineering Co., Glasgow.

Turbine Pumps in Mines.—The *Iron and Coal Trades Review* for August 15 prints a paper read by L. Hughes before the Association of Mining Electrical Engineers describing a pumping installation at the Nantgarw colliery, South Wales, where water from the upper parts is made to drive the turbine pump employed in draining the mine.

Winding Engines.—The *Iron and Coal Trades Review* for August 8 describes a new method of attaching ropes to winding drums, invented by J. S. Sparks.

Conveyor for Mines.—The *Colliery Guardian* for August 8 describes the McDonald conveyor for carrying coal or ore from the working face.

Copper Leaching.—In the *Mining and Scientific Press* for August 2, Percy R. Middleton continues his account of the electrolytic recovery of copper from solutions derived from the leaching of roasted concentrate. The article is based on work done in Australia, notably at Mount Morgan.

The Horwood Process.—In the *Mining and Scientific Press* for August 2, A. H. Heller describes the flotation plant at the Afterthought copper-zinc mine, Shasta County, California. The Horwood process is employed to give the mixed concentrate a roast, which oxidizes the chalcopyrite and pyrite, but does not affect the blende, and the material is then treated in flotation cells.

Tin Analysis.—The *Journal of Industrial and Engineering Chemistry* for August contains a paper by Archibald Craig discussing the conditions of greatest accuracy of the analysis of tin alloys based on the nitric acid separation.

Electrolytic Zinc.—The August *Bulletin* of the American Institute of Mining and Metallurgical Engineers contains a paper by C. A. Hansen describing experimental work at Bully Hill, California, in connection with the roasting of zinc ores before treatment by the electrolytic process.

Volatilization of Silver.—In the *Engineering and Mining Journal* for July 19, F. P. Dewey points out the difference between true volatilization losses and dust losses.

Platinum.—In the *Engineering and Mining Journal* for July 26, James J. Hill reviews the platinum position, giving its uses, particulars relating to output, and future prospects.

Reverberatory Practice. — In the *Mining and Scientific Press* for July 19, Walter G. Perkins writes on the advantage of the reverberatory over the blast-furnace in copper smelting, and refers to his type of reverberatory built on the regenerative principle.

Reverberatory Practice.—In the *Mining and Scientific Press* for July 19, O. E. Jager describes the method of strengthening the roofs of reverberatory furnaces adopted at Anaconda.

Belgian Congo.—In the *Engineering and Mining Journal* for August 9, S. H. Ball and M. K. Shaler give particulars of mining activities in the Belgian Congo during the years 1915 to 1918.

Sydvaranger, Norway.—The *Iron & Coal Trades Review* for August 22 describes the Sydvaranger iron mines in the north of Norway and the method of concentrating and briquetting the magnetite.

Pilares.—The August *Bulletin* of the American Institute of Mining and Metallurgical Engineers contains a paper on the Pilares copper mine at Nacozari, Sonora, by W. R. Wade and A. Wandtke. The mine belongs to the Moctezuma Co., one of the Phelps-Dodge group. The article gives an account of the geology of the district and the methods of mining the ore deposits.

Wisconsin Zinc.—The August *Bulletin* of the American Institute of Mining and Metallurgical Engineers contains a paper by W. F. Boericke and T. H. Garnett on the Wisconsin zinc district.

Matachewan, Ontario.—In the *Canadian Mining Journal* for July 19, R. E. Hore writes on the Matachewan gold ores, and in *Economic Geology* for June H. C. Cooke writes on the origin of the gold deposits.

Placer Mines of Cariboo, British Columbia.—By J. B. Tyrrell, *Economic Geology* for June.

Shasta County, California.—In the *Mining and Scientific Press* for July 12, Herbert Lang continues his account of a metallurgical journey through Shasta County, and deals with the treatment of sulphide ores, some of them complex, in the Kennett district.

Petroleum.—In the *Journal of Geology* for June, A. W. McCoy discusses the principles of oil accumulation in rocks.

Petroleum.—In the July *Bulletin* of the American Institute of Mining Engineers, S. St. Clair describes the Irvine oil district, Kentucky.

Norfolk Oil Shales.—*The Financial Times* for August 29 and 30 contains an account of the Norfolk oil-shale venture, based on an interview with Dr. Forbes-Leslie.

Potash.—In the *Mining and Scientific Press* for August 9, H. H. Roe describes the Californian potash deposits and the method of working them.

Nelson Cell.—*Chemical and Metallurgical Engineering* for August 1 describes the cell for electrolytically decomposing brine, invented by H. R. Nelson and used by the Warner Chemical Co., at Carteret, New Jersey.

Mexican Mining Law.—The *Engineering and Mining Journal* for August 2 gives the new Mexican mining law.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W C.2. with a note of the number and year of the patent.*

6,549 of 1917 (129,300). E. Camus, R. Duchemin, and G. Crique-Bœuf, Paris. Making lead acetate by acting with lead oxide on ethyl acetate.

15,672 of 1917 (129,349). G. F. Forwood and J. G. Taplay, London. Removing sulphur from oils by agitating with a solution of a sulphide of an alkali or alkaline earth metal.

15,768 of 1917 (129,354). G. Jakova-Merturi, Paris. A regulated gaseous mixture composed of hydrogen and carbonic oxide for reducing iron ores without solid fuel.

17,031 of 1917 (129,667). H. W. C. Annable and Nickel Concentration, Ltd., London. Process for obtaining a water-soluble nickel salt from sulphide ore or matte; the material is heated with common salt, with or without a sulphidizing agent such as pyrites, to a temperature of 800 to 1,000°C. in a neutral atmosphere, and subsequently the mass thus obtained is oxidized at a temperature high enough to decompose the sulphates of copper and iron but not high enough to decompose the nickel sulphate.

18,179 of 1917 (129,721). W. E. Gibbs and R. J. Gilderson, Southampton, and H. E. F. Goold-Adams, London. Filtering apparatus for the recovery of fume in metallurgical works.

703 of 1918 (130,069). R. C. Parsons and H. C. Jenkins, London. Manufacture of ammonia by the catalytic process, using the pure hydrogen obtained in the Jenkins cell for electrolysing common salt, as described in an article in this Magazine for June.

2,186 of 1918 (130,381). W. A. Naish, London. A strong aluminium alloy that does not require subsequent heat treatment, composed of 90% Al, 6% Zn, 1% Fe, 1% Si, Mg 0·5%, with slight variations in the range of each constituent.

6,065 of 1918 (129,392). J. Nelson and W. C. White, Glasgow. Method of producing amorphous metallic lead powder suitable as a paint.

11,198 of 1918 (129,426). Sir R. A. Hadfield, Sheffield. Method of producing a ferro-manganese low in carbon in an electric furnace.

11,385 of 1918 (129,443). R. de H. St. Stephens, and Climax Rock Drill & Engineering Works, Ltd., Camborne. Valve mechanism for hammer drills so constructed that the extent of the movement of the valve may vary considerably owing to wear or variation of manufacture without impairing the efficiency of the valve, and also so that the valve may be made so light that wear and tear and consequent cost of maintenance are reduced to a minimum. Claims: (1) In valve gear for rock-drills and other percussion tools wherein a hollow cylindrical valve travels between two ports in a valve box in a direction at right angles to its axis and closes the said ports by means of its peripheral surface, constructing the said box so that spaces are formed between the valve and the ends of the said box into which spaces live air is admitted to move the said valve, substantially as described. (2) In valve gear of the kind hereinbefore referred to for rock-drills and other percussion tools, a valve box comprising a cylindrical sleeve, the interior of which is of rectangular section closed by two end plates in which ports are formed, the spaces between the valve and the said end plates being connected to the live air supply passage, substantially as described.

12,125 of 1918 (130,446). Q. MARINO, London. Method of electro-plating iron and steel with copper.

12,199 of 1918 (130,160). R. DE H. ST. STEPHENS and CLIMAX ROCK DRILL & ENGINEERING WORKS LTD., Camborne. Improved method of introducing water through the drill steel in rock-drills.

12,232 of 1918 (130,164). R. WELFORD, London. Making a soluble aluminium salt by treating ordinary clay with hydrochloric acid, and catching the escaping vapours and treating them for the recovery of chlorine or other bleaching product.

12,811 of 1918 (129,485). F. H. BROOKE, Sheffield, and T. TWYNAM, Redcar. Use as a binding agent for high-grade refractory bricks of fine dry flue-dust from the down-comers of blast-furnaces, this dust being high in magnetic oxide of iron.

13,134 of 1918 (129,156). W. F. BENNETT, Carbis Bay, Cornwall. Improved igniting device for fuses.

13,183 of 1918 (130,483). TAKEKICHI ARAMAKI, Tokyo. Apparatus for melting zinc.

13,932 of 1918 (130,494). A. J. HENDERSON, London. Removing tin from tinplate or zinc from galvanized iron, by heating the scrap to a temperature above that of the coating metal and removing the coating metal by a strong blast of superheated steam.

14,238 of 1918 (119,229). A. and M. HIRSCH, New York. Electrolytic method of producing metallic cerium and other rare earth metals and their alloys, these metals being intended for use in ignition devices.

14,350 of 1918 (129,166). W. E. POOLE, Leeds. An electro-magnetic separator which holds the magnetic material on the outer surface of a cone, and in which the outlet for the non-magnetic material is closed automatically when the current is cut off and the magnetic material falls.

14,694 of 1918 (130,198). A. FRANKIGNOUL, The Hague. Modifications in the inventor's blast-furnace in which the reduction of iron ores is effected by gaseous fuel and the spongy iron produced melted electrically.

15,113 of 1918 (119,243) A. R. LINDBLAD, Stockholm. Improved construction of electric furnaces used for the synthetic production of cyanides and nitrides.

16,238 of 1918 (130,216). A. T. NUTT and F. A. HARVEY, Sheffield. Improved construction of doors of metallurgical furnaces.

5,728 of 1919 (129,598). J. T. WADE, High Wycombe. Construction of air compressors; one object is to provide an apparatus whereby air is drawn or sucked into the cylinder both on the outward and on the inward stroke of the piston. A further feature consists in so constructing the apparatus that the suction and delivery pipes are enclosed by a water jacket arranged in the upper part of the cylinder, in such a manner that any number of cylinders may be coupled together side by side to be served by common delivery and suction pipes. The pipes being enclosed in the upper part of the cylinder or cylinders dispenses with the unsightly delivery, suction and air pipes, while the size and weight of the compressor for a given output are considerably less than with such apparatus as at present constructed. The crank case is provided with an air inlet controlled by a flexible valve through which air is drawn or sucked on each outward stroke, the air being delivered or transferred to the top of the cylinder above the piston through ports uncovered by the piston at the end of each return stroke. The suction and delivery pipes extend transversely at right angles to the axis of the cylinder and are enclosed in a water jacket. The ends of the pipes terminate in vertical flanges by means of which any number of cylinders may be coupled together side by side, the suction and delivery pipes registering with one another so as to form common pipes for all the cylinders. The crank case is provided on each side with a suitable housing for bearings forming a special feature of the invention. These bearings are formed in two parts registering with one another and bolted together in any suitable manner. The chamber forming the housing for the bearings on one side is closed in an air-tight manner by a disc, plate, or cover secured by any convenient means, while the housing on the opposite side is provided with two or more diaphragms arranged side by side and pressed into contact with an annular flange on the crank shaft, by springs mounted at the end of the adjoining bearing so as to form an air-tight joint. The diaphragms are secured to the housing by a cap or the like fixed by bolts or set screws.

6,089 of 1919 (126,274). P. COMMENT, Dijon, France. Improvements in the inventor's method of producing anhydrous sulphide of zinc.

9,012 of 1919 (125,397). SOCIETA ANONIMA STABILIMENTI BIAK, Turin. A zinc alloy that can be forged and turned, containing 85 to 96% Zn, and small portions of Cd, Ni, Fe, Al, Zr, Mn, and Cu.

10,314 of 1919 (130,302). Q. MARINO and C. BOWEN, London. Electrolytic process for coating iron and steel with lead, antimony, or lead-antimony alloy.

10,358 of 1919 (129,596). W. D. BERRY, New Brighton, Pennsylvania. A bearing metal containing no tin, and consisting of 79% copper, 14% lead, 6% antimony, and 1% phosphorus.

10,490 of 1919 (126,296). ELECTROLYTIC ZINC CO. OF AUSTRALASIA, Melbourne. Improvements in methods of eliminating cobalt from solutions to be electrolysed for zinc.

11,216 of 1919 (129,958). F. M. MOONEY, Montreal. Method of producing pure chromium sulphate from chromate or bichromate of sodium or potash.

NEW BOOKS

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

Mineral Deposits of South America. By B. L. Miller and J. T. Singewald, Jr. Cloth, octavo, 600 pages, illustrated. Price 25s. net. New York: McGraw-Hill Book Co.; London: Hill Publishing Co., Ltd.

A first-hand description of the mineral deposits of a continent rich in minerals of every description widely distributed would have been a tremendous undertaking. Fortunately data, already recorded by many authors, was available. This has been frankly acknowledged by the authors of this book, but they have selected and made the best use of it after careful observation and study, frequently on the spot. Owing to the vastness of the subject, the descriptions of certain countries have been reduced to mere synopses, but on the whole the authors have succeeded in condensing in one compact volume a fund of reliable information which will be of assistance and value to engineers, geologists, and financial men interested in mining concerns of South America. The mineralogical and geological diagnoses are excellent. In particular the accounts of the iron deposits of Brazil, the tin deposits of Bolivia, and the copper and nitrate deposits of Chile and Peru are instructive.

Under physiographic divisions, we think that the Bolivian altiplanicie, or "highland" as the word indicates, should have been classed with the other highland groups and not included under Cordillera. From the time of the Spanish conquest this portion of the continent has always been known as the Bolivian highland, as distinct from the adjoining mountain chain of the Cordillera or Andes.

The suggestion that a huge flow of andesite in the vicinity of the richest tin deposits is likely to have covered other important deposits of tin is an interesting theory inviting investigation.

It may be said that the book in general treats of the mineral deposits too exclusively from a geologist's point of view. A detailed description of the actual workings of some of the more important mines, with small-scale plans, as well as descriptions of their reduction works and the outputs of mineral or metal would have enhanced the value and interest of the book.

Some of the statements regarding the copper mines of Argentina are out of date, while more should have been made of the mines of antimony, silver-lead, coal, and the deposits of petroleum. Similarly the mineral deposits of Western and Southern Brazil have been little more than referred to.

Undoubtedly preference has been given, and rightly, to the mineral deposits of Chile, Peru, and Bolivia, as they constitute three-fourths of the mining industry of South America, but we look for increased activity in the development of coal, iron, silver-lead, and petroleum in Brazil, Uruguay, and Argentina; while in Colombia and Venezuela those of oil, platinum, silver, and gold seem to hold out considerable hopes of expansion.

We would suggest that information might have been given regarding the mining laws regulating the granting of concessions and claims, the size of each claim and the maximum number that any one prospector or company is entitled to have allotted. These vary in each republic, and it would have been interesting to know to what extent.

The Governments of some South American states might be approached by the authors with a view to compiling separate volumes dealing in detail with their mineral deposits. The Argentine Government, for instance, has the most elaborate and accurate geological plans and studies made by eminent geologists, and possesses a fine museum of minerals collected in the country, but there are practically no working mines. An up-to-date description giving the real reasons why so many promising mines and ventures have been abandoned, with suggestions as to scientific development and suitable ore treatment, would attract foreign capital, if indeed it would not induce the Government itself to reopen and work them.

The authors use Spanish local technical terms freely. This is confusing to those unacquainted with the language, while to those who are conversant it is superfluous and out of place, especially when the terms are not correctly applied.

The authors have produced an excellent work, and one which will prove a valuable addition to the technical libraries of engineers, institutes, and companies.

RALSTON C. SHARP.

Jernmalm og Jernverk. By J. H. L. Vogt. Memoir No. 85 of the Norwegian Geological Survey. This publication gives particulars of the iron ore deposits of Norway, at Arendal, Kragerö, Nissedal, Nordmöre, Trondhjem Fjord, Tromsö, Sydvaranger, Bogen, and Dunderland. An account is also given of the more celebrated deposits in Sweden, much of the ore from which is exported through Norwegian ports. The volume contains a discussion of electric means of smelting iron ores that would be applicable in a country such as Norway with water resources but no coal.

Journal of the Institute of Metals, Vol. XXI. This volume contains a report of the meeting held in March of this year.

Far Eastern Mines of the Witwatersrand. Edited by A. N. Jackman. Pamphlet, 72 pages, with map. Price 3s. 6d. net. London: *The Financial Times*. This gives particulars of all the gold-mining companies owning properties or operating in the Far East Rand.

Annual Report of the Ministry of Mines of British Columbia, 1918. By W. Fleet Robertson, Provincial Mineralogist. Quarto, 505 pages, with many illustrations.

COMPANY REPORTS

Forum River (Nigeria) Tin.—This company was formed in 1912 by the Northern Nigeria Trust to acquire tin properties on the Forum, Du, and Bukeru rivers. A. W. Hooke is manager. The report for the year ended March 31 shows that 220 tons of tin concentrate was produced as compared with 325 tons the year before, the fall being due partly to the influenza epidemic and partly to the scarcity of labour caused by the native dislike of the new paper currency. The net profit was £10,062, as compared with £28,203 the year before. The shareholders received £10,875, being at the rate of 15%. Out of the previous year's profit, £12,100 was paid as excess profits duty; no such duty is payable this year. The company has acquired 83 acres of additional ground under mining lease during the year, making the total held under lease 2,277 acres The company also has mining rights covering six miles of streams. It owns jointly with the Bisichi company exclusive prospecting licences over nine square miles, and application has been made for two other licences covering three square miles.

Leadhills.—This company was formed in 1876 to acquire lead mines in Lanark, Scotland. W. B. Skewis is manager. Some particulars of the district were given in our July issue. The report for the year ended June 30 shows that 1,841 tons of ore and concentrate was produced, and 2,006 tons sold. The receipts from the sales totalled £41,668, being at the rate of £20. 15s. 5d. per ton, and the net profit was £3,095, of which £1,318 was interest on investments. With the recent fall in the price of lead the position has become an anxious one. At the present time all hands are employed in raising ore and developments are curtailed.

Kampong Kamunting Tin Dredging.—This company was formed in Sydney in 1913, and was reconstructed in 1916 under Federated Malay States law. The property is situated at Kamunting, about three miles from Taiping, in the state of Perak. The first dredge started in March, 1915, and a second in February, 1916. Each dredge has a capacity of 90,000 cu. yd. per month. A. W. Freeman is chairman of the company, and A. J. King is manager. The report for the half-year ended December 31, 1918, shows that the two dredges treated 954,500 cu. yd. of ground for a yield of 444¾ tons of tin concentrate, equal to a yield of 1·04 lb. per yd. The income was £73,090, and the working cost £19,721, leaving a working profit of £53,369. Out of the profit, £3,495 was allowed for amortization of the mine, £2,433 was written off for depreciation of plant, £3,500 was written off stores account, and £1,323 was spent on administration. The dividends absorbed £42,000, being at the rate of 6s. per £1 share. During the year 1918, 80 acres of tin ground were purchased. The total dredging area available at December 31 was 519 acres, sufficient to occupy the dredges for 12 or 13 years.

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.SC., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill*, both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION: U.K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XXI. No. 4. LONDON, OCTOBER, 1919. PRICE ONE SHILLING

CONTENTS.

EDITORIAL

PULVERIZED coal is to be used in the blast-furnaces at the Cerro de Pasco copper mines in Peru. The five furnaces now in commission will be modified accordingly, and new furnaces are to be built on the improved system.

OLD students of the Camborne School of Mines are invited to send their present addresses to Mr. Raymond Prisk, editor of the School Magazine, which is to be revived during the coming term. It is hoped that eventually a register of old students will be published, giving their records both in the profession and at the war.

WE take pleasure in drawing the attention of our readers to an excellent series of articles now appearing in *The Financial Times* entitled "Mines and the Speculative Investor." These are written by Mr. J. A. L. Gallard, the mining editor of our morning contemporary, and a journalist qualified by acumen, experience, and honour to act as a sane adviser in connection with a subject extremely difficult to handle. For the benefit of those who do not see the newspaper in question, we may add that the articles are to be republished in book form.

AN American contemporary recites the fable of the dog dropping its mouthful in order to grasp at the reflection, in connection with what it calls the greedy policy of Minerals Separation, Ltd. We should not be surprised if the controllers of the company brought out a revised version of the fable in reply, recounting how the dog was tired of the shadow, which in this case stands for the so-called protection afforded by the patent law, and made a bold dash for the real substance, namely, the dollars due to the inventors of a valuable process.

STATISTICS of gold production are difficult to interpret exactly owing to the various ways of reporting the output, fine, standard, and bullion ounces, and theoretical and realized value being adopted according to the predilection of manager or board. The question arises at present whether the mines will report their gold output at realized value or at par value, and the statistical returns will obviously have to be watched closely if track is to be kept of the actual amount of gold obtained. These new conditions point to the troy ounce as the best unit for reports of gold production. As we go to press we have received notice that the Transvaal mines will use par value in the monthly returns of output and will report separately every quarter the premiums received.

LIKE many other mineral deposits in Central Africa, the Rhodesia Broken Hill lead-zinc ores have presented difficulties in development, not merely those due to lack of transport and fuel, but also those connected with the nature of the ores themselves. The outcrop contains oxidized compounds of both lead and zinc, and no doubt the absence of precious metal made the ores unattractive to earlier civilizations. The wide variation in the relative proportions of the base metals and the uncertainty as to the nature of the orebodies in depth made their exploitation far from simple. The problem has been solved by Mr. S. J. Speak, of the firm of Messrs. Hooper, Speak & Co., and it is with no small pleasure that we print in this issue his account of the deposit and of the methods of mining and treating the ore. This description will enable shareholders and the public to obtain an intelligent grasp of the business in hand, and hereafter to follow the progress reports as they are published. We take this opportunity of thanking Mr. Edmund Davis and the other directors of the Rhodesia Broken Hill Company for acceding to our suggestion that this article should be written.

AT the meeting of the British Association held at Bournemouth last month, there were one or two papers of interest to mining engineers. The president, Sir Charles A. Parsons, made brief reference to the heat of the interior of the earth as a possible future source of power, and he revived his proposal of a dozen years ago to sink a shaft ten or twelve miles deep in order to tap this heat. From the point of view of the mining engineer such a project seems out of the range of present calculations. Sir Charles also drew attention to the power plant erected in Italy to utilize volcanic steam, a project to which we referred in December, 1916. Another paper of interest was that by Dr. J. W. Evans, president of the Geological Section. He dealt with a number of subjects relating to economic geology, and he showed how the geologist and the mining engineer could be mutually helpful.

In particular he reminded engineers that information obtained during mining operations with regard to the nature of rocks and ore deposits would be most gratefully received by the geologist, who as a rule has too often to depend on quarries, railway cuttings, and outcrops for his investigations. The results of drilling operations would also give him many useful hints, and we pass Dr. Evans' request on to our readers that they should give petrologists the opportunity of examining cores. Boring has never been a feature of work of the Geological Survey, and it would be too much to ask the Government to provide funds for such an innovation, useful as it would be. From the point of view of the geologist and petrologist, the cable or percussive prospecting drill is of little use, for only the drill that preserves a core is of help in examination of the material raised. We endorse Dr. Evans' suggestion that mine managers should afford the geologists every opportunity to study the rocks and minerals disclosed during development. The advantage would be mutual. Elsewhere in this issue we reproduce some of Dr. Evans' remarks on modern theories in economic geology.

THE ventilation of deep mines is a subject which is gradually forcing itself on the mining profession, and in the future it will continue to demand increasing attention. The Institution of Mining Engineers has devoted a considerable amount of time recently to the collection of information on which to found a general discussion, and it has been responsible for most of the research undertaken by a committee appointed by the Department of Scientific and Industrial Research. In this issue we quote the preliminary report of this committee, and we give a brief abstract of remarks made by Mr. Eric Davis relating to the cooling plant at St. John del Rey. In our last issue we quoted Mr. E. H. Clifford's remarks on the problem at City Deep. The work of the Institution of Mining Engineers is naturally directed to the consideration of the atmosphere of coal mines in this country, but the principle involved is the same as in metalliferous mines. It is true that the primary object of ventilation in coal mines in earlier times was to prevent the accumulation of poisonous and explosive gases, but nowadays the question of heat and moisture constitutes the basis of discussion. The fundamental point is the lowering of the heat and the reduction of the moisture content of the mine air, and of the two the latter is of the greater importance. In a coal mine and in the majority of metal mines it is possible to keep the atmosphere moderately dry by delivering air which has been cooled and dried in a refrigerating plant on the surface. At one time it would not have been considered safe to have the air in a coal mine too dry, for the coal dust in the roads when disturbed would have been dangerous as leading to explosions. The present practice is, however, to rely on stone dusting instead of water spray in reducing the inflammability of coal dust, so that it is now permissible to dry the air. This is virtually as far as the committee's report takes us, and no mention is made of the metal mines where the dust is harmful to the lungs, as it is on the Rand. Here it is necessary to allay the dust by means of water. It is clear that a contradiction of conditions here exists, and that there is a difficulty in keeping the air sufficiently dry and at the same time preventing the formation of clouds of dust. The decision as to the advisable compromise in this case depends to a large extent on the variation of the normal moisture content according to temperature. At each temperature there is a moisture content which gives the maximum of agreeable feeling to the human system, and too low a content is as inimical to comfort as an undue dampness. Ventilating engineers who warm the outside cold air and deliver it direct into the interior of a building often forget this fact; and most people do not know exactly why they find it beneficial to place a vessel of water on top of an anthracite stove. No doubt all these intricacies of the moisture laws will receive full attention and discussion as the consideration of deep-mining conditions proceeds.

Spitsbergen.

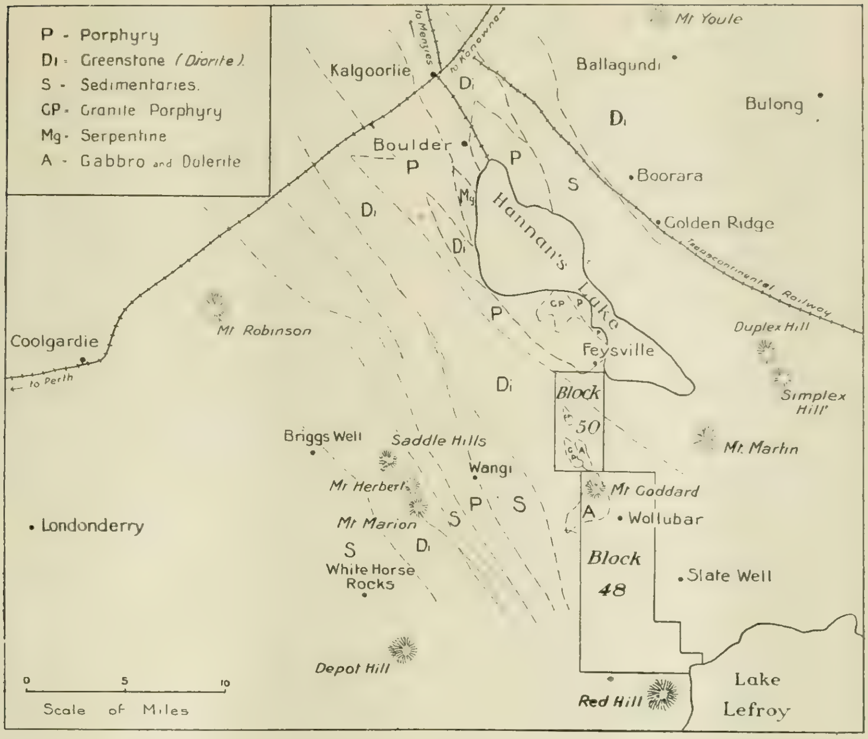
Representatives of the Northern Exploration Company have returned from Spitsbergen, and it is announced that another trip will be made before the present season closes. No report by Mr. W. Selkirk, the company's consulting engineer, has yet been issued relating to the iron deposits at Recherche Bay, nor have the views of the company's American commission, which included Messrs. Boyce, Thompson, and Higgins, been made public. In the meantime, Mr. Rolf Marstrander returns to the attack in a letter published elsewhere in this issue, and gives a mass of specific detail, some of it asked for by Mr. Ernest Mansfield, and some not.

The news from Paris is to the effect that the Allied Council have granted Norway's claims to the sovereignty of Spitsbergen. Though Great Britain also submitted a claim, we believe that the decision is a right one and will be accepted with good grace in this country. The extent to which Norway is interested in Spitsbergen minerals is not generally known, and the following brief notes on the subject will serve to enlighten our readers. The most important Norwegian company operating in Spitsbergen is the Store Norske Spitsbergen Kulkompani, of Christiania. This company is now concentrating its operations on its Coal Tract No.1, situated between Advent Bay and Coles Bay. The claims covering this tract were originally obtained by Norwegians in 1900, who sold them in 1905 to the Arctic Coal Co., an American corporation controlled by Messrs. Longyear. It will be remembered that Mr. Scott Turner was manager for this American company for some years. In 1916 the Arctic Coal Co. sold its property to the Store Norske. The output of coal during the nine years 1907 to 1915 inclusive totalled 150,000 tons, and during the four years 1916 to date it has been 135,000 tons. It is intended later to increase the output by developing the seams in Green Harbour. Since the Store Norske acquired the property two million kroner has been spent on development, plant, means of transport, and housing accommodation. Another company is the De Norske Kulfelter Spitsbergen A.S., having its headquarters at Bergen. The coal lands are at Advent Bay. During the winter of 1918–19, sixty men were employed in development, erection of plant, houses, etc., and regular mining work was to start this summer. The King's Bay Coal Co., with headquarters at Aalesund, had 300 men working in the summer of 1918 and 146 in the winter of 1918–19. Up to the time of the last report, 35,000 tons had been shipped. The scale of operations is being expanded this summer. The Spitsbergen Kul & Mineral A.S., of Christiania, started development at Bell Sound in 1918, and this year sold the property to an English company. The Svalbard Kulgruber Spitsbergen A.S., of Christiania, owns property south of Green Harbour, and is raising additional capital to resume development. The Björnöen A.S., of Stavanger, has produced 15,000 tons of coal since 1917, and last winter had 80 men on the property. The Kulspids A.S., of Christiania, is developing an asbestos deposit on Bell Sound. Last year's expedition consisted of 26 men, and 16 tons of asbestos was shipped. Since 1916 the mineral output of Norwegian firms has been nearly three times as great as the output of any other nation operating in Spitsbergen.

The Hampton Plains Discovery.

The London share market has had a mild sensation in the way of a miniature gold-mining boom this month. News arrived of a new discovery of lode-gold in Blocks 48 and 50 on Hampton Plain, about 35 miles south-east of Kalgoorlie. Holders of shares in Hampton Properties, Ltd., hunted up their certificates and rubbed their hands gleefully when the shares that had been unsaleable at three-halfpence were pushed up by interested stockbrokers to over £2. The shares of Hampton Uruguay also came to life again. The whole affair is, of course, a wild speculation, but there is a basis of solid scientific fact behind the discovery, though stockbrokers and the public do not know it, and even if they knew it they probably would not care. We can safely leave the sharemarket to look after itself, and proceed to discuss the discovery from the technical point of view.

Twenty-five years ago prospecting throughout West Australia, particularly in the Kalgoorlie district, was at its height. Financiers and prospectors were alike keenly searching for gold deposits. Immediately to the south and east of Kalgoorlie the salt lakes and alluvial tracts prevented any systematic tracing of the Kalgoorlie line of lodes, but farther to the south, on country such as in Blocks 48 and 50, it was possible to follow the outcrops. In many places in this neighbourhood the alluvium contained gold, and for a time the dry-blowers did fairly well. Coarse gold was found freely, and a number of notable nuggets were discovered, of which Mr. St. John Winne's "butterfly" was perhaps the most attractive. The attempts to discover outcrops of lodes as valuable as those at Kalgoorlie were not attended with success. The veins that were worked were invariably in quartz and did not yield much gold, nor did they continue in depth. Thus for a long time now little has been heard in the mining market of the region south of Kalgoorlie, but the geologists and the scientific prospectors have not been idle. The Geological Survey of West Australia has paid attention to the district, and, in particular, valuable reports have been made by Mr. Sydney Honman, a field geologist of the Survey. His work is recorded in Bulletins 56 and 66, which were published in 1914 and 1916 respectively. The sketch map which we give on next page has been prepared from the maps accompanying these bulletins. From these it will be seen that the Kalgoorlie geological zone continues in a south-easterly direction, and that the prospector is justified in hoping to find something



MAP OF THE DISTRICT TO THE SOUTH OF KALGOORLIE.

good along this line. The West Australian Government has, since the war, supplemented the Survey service by instituting a course of instruction for prospectors. Early last year a committee, of which Mr. C. M. Harris was the most active member, was appointed to organize this instruction and to send parties out with definite objectives in view. To meet the expenses of this scheme the Federal Government provided £5,000, and the State Mines Department supplied the equipment. Mr. Torrington Blatchford, a young member of the Survey, who is now Assistant State Mining Engineer, is keenly interested in these prospecting schemes, and with his modern ideas of applied geology he may be expected to organize a comprehensive plan for examining the whole of West Australia. The main feature of the new system of prospecting is the method called "loaming," devised for discovering buried outcrops. By this method the metallic content of the superficial covering can be traced to its ultimate source. Mr. Harris is describing the system in a paper to be read at the Institution of Mining and Metallurgy held on October 16, the day after the publication of this issue, so we must hold over the full account until next month.

The recent discoveries at Blocks 48 and 50 are the outcome of this enterprise. Hansen, to whom the credit of the discovery is due, is a type of the modern prospector, acting under the advice of experienced mining engineers and geologists. In this case the lode was discovered under the overburden, and testing by means of shallow trenches has proved the lode to be 20 ft. wide for a length so far disclosed of 200 ft. The samples have assayed up to 100s. per ton. The latest reports show that a shaft has been sunk on the lode to a depth of 50 ft. and that the assay-value of the ore has been maintained. The plan will be to sink to 100 ft. and then to drive along the lode. On Block 48, Slavin and Eivers have proved the lode over a length of 500 ft. and assaying 1 to 1½ oz. over about 5 ft. The details on which a judgment as to the eventual importance of these discoveries can be made have not yet been received in this country, and it is quite possible that their importance has not yet been fully grasped on the spot. Those who have studied the Kalgoorlie deposits are aware that the nature of the country rock serves as an indication of the value of the lodes. What we want to know is whether the newly discovered lode is in quartz-dolerite. If so the discovery may be one of prime importance. On the other hand, should the country rock be a calc-schist, the importance of the find will not be so great. At the present time our efforts to obtain this specific information have not been attended with success. It is a pity that the West Australian Department of Mines is not able to cable a fully descriptive statement, for, as we have said, a lode in quartz-dolerite correlates the discovery with the lodes on the Golden Mile, whereas if in calc-schist the ore deposits are likely to be erratic, although at the same time rich.

The James Watt Centenary.

The centenary of the death of James Watt was commemorated by a series of meetings held at Birmingham last month. The celebration was organized by the civic, university, and other interests in that city, and none of the scientific and engineering societies participated. Thus the event lacked national importance. The meetings also suffered to some extent from the fact that they were held at a time when the societies were engaged with their own particular business. The British Association had monopolized the whole of the previous week, and the days following were claimed by the Iron & Steel Institute and the Institute of Metals. Under these conditions the celebration received little more than local attention, and its chief object, the raising of a fund to endow a chair of engineering research at Birmingham University, was by no means attained. It can hardly be doubted, however, that the leaders of industry in the great city of the Midlands will eventually ensure the success of this educational enterprise and found a professorial chair worthy of both the University and the inventor.

James Watt's perfection of the steam engine is of particular interest to mining engineers, for, it will be remembered, steam power as adapted by Newcomen was utilized chiefly for pumping at mines, and the first engines designed by Watt were improved Newcomen mine pumps. . Much of his work of applying steam to pumping was done in consultation with Cornish mining engineers, and the Cornish pump of to-day is virtually the Watt invention. With regard to the services rendered by Watt to engineering science, it may be said briefly that his invention consisted in the use of a separate condenser for the exhaust steam and in the utilization of the expansive power of steam. Before his time direct steam pressure had been used to push a piston along a cylinder, and the contained steam had been cooled and condensed within the same cylinder. By this alternate heating and cooling of the cylinder vast amounts of energy had been wasted. Watt kept the cylinder at the same temperature, and pumped the exhaust steam into a chamber that was always cool. The cutting-off of the entering steam during the forward stroke of the piston was another important source of conservation of power.

It has often been wrongly supposed that Watt was a poor inventor struggling against neglect. This legend has presumably arisen from the fact that much of his later research work was done in a garret. This garret, however, was part of his comfortable residence, Heathfield Hall, and he occupied it with the express object of defeating the host of sneak-thieves who proverbially surround a successful inventor. Watt's biographies show him to have been a scientific man primarily. He was the son of a Scottish philosophical instrument maker, and he plied the same trade under the auspices of Glasgow University. He also practised as a surveyor in connection with civil engineering projects. His attention was turned to steam by having been asked to investigate the faults of a Newcomen engine. Thereupon he made a complete study of the mechanical and physical properties of gases, and his improvements in the steam engine were the result. Offers of financial assistance came readily, and eventually he joined forces with Matthew Boulton, a Birmingham engineer, and he spent the rest of his life in the Midlands.

There is one feature of his experience that deserves special mention. We refer to the virulent opposition which was offered to his applications for patents. Even in those days the inventor of a method which revolutionized technical practice had to fight fiercely for his rights against jealous rivals. It was alleged that there was nothing patentable in the use of a separate condensing chamber. Moreover, one of his opponents took the early opportunity of patenting the crank and connecting rod as a means of converting rectilinear into rotary motion, thus making it necessary for him to adopt the weird devices that strike the present-day visitor to the Science Museum with untold wonder. In later days, when he was devising a machine for copying sculpture, labouring secretly in the Heathfield garret, he was informed that another inventor in the neighbourhood was engaged on the same problem, and he was invited to join forces. Being a gentleman, he did not say: "You be 'Fishered'"; he merely declined the invitation, and abandoned that particular line of research with calm regret.

REVIEW OF MINING

Introduction.—Labour questions reached an acute stage at the end of last month by the action of the National Union of Railwaymen in declaring a strike and paralysing the entire railway system of this country. After ten days' idleness the railwaymen were induced by the leaders of other trade unions to accept the Government's promise to find a solution of the difficulty and in the meantime to go back to work. In the iron trade strikes are also prevalent. Altogether the business of the country has been seriously crippled. In the mining market, the publication of brief details of the objects of the new Mexican Corporation, a big boom in oil shares, the continued rise in the price of silver, the rejection of nationalization of mines by the Government, and the gold discoveries south of Kalgoorlie have been the leading features of interest.

Transvaal. — The market in Far East Rand shares has been booming in Johannesburg during the last month, owing to the influx of buying orders from London following the relaxation of Treasury restrictions. Modder East, West Springs, and New State Areas have received particular attention, and the shares have advanced considerably in price. These shares may be expected to give substantial returns to early investors, during the first years by appreciation of capital value, and then by the distribution of steady dividends.

The directors of New Modderfontein have decided to split the £4 shares into eight of 10s. each. The cabled report states that on June 30 the ore reserve was estimated at 8,854,300 tons averaging 8·5 dwt., as against 9,000,000 tons averaging 8·6 dwt. on June 30, 1918.

The new vertical North Shaft at Randfontein Central intersected the reef at a depth of 3,210 ft., at a point over 1,000 ft. below the present deepest workings. The reef dips at 60°. Drives along the reef show an average assay-value of 11 dwt. per ton over 48 in. stoping width. This is a distinctly favourable feature for the future prosperity of the mine.

The Grootvlei company is offering 250,000 shares at 21s. each, carrying the right to subscribe to a similar amount at 25s. within two years. This company belongs to the Lewis & Marks group, and holds the mineral rights, excepting for coal, over the whole of Farm Grootvlei in the Far East Rand, east of Geduld and north of Daggafontein. Bore-holes sunk some years ago proved the presence of the gold-bearing reef, and two shafts were commenced, but work was suspended owing to water troubles. The mynpacht originally chosen was at the northern end of the farm, and the shafts were sunk there accordingly. Present plans, however, show that the original mynpacht has been abandoned, and the part of the farm now claimed is the south-western, nearer to Daggafontein, Springs, and New State Areas. It is also intended to apply to the Government for additional ground under lease.

The Sheba group of mines is to be reopened, the time having come when, in the opinion of the board, development can be done sufficiently cheaply. The company is to be reconstructed with a liability of 1s. on the 1,084,954 shares of 5s. each.

Cable advices give a brief outline of the interim report of the Government Commission on Low-Grade Mines. The report states that whereas there were fourteen Witwatersrand mines at the end of 1917 working at a loss, or at a profit of 2s. or less per ton, three of these mines have since closed down, and the number of such mines has increased to twenty-one, representing roughly half of the Witwatersrand industry as regards employment and expenditure. Other factors rendering the position more serious are the greatly increased assessments under the new Miners' Phthisis Act and the fact that the mines are working an unduly large proportion of their better grade ores. The Commission makes three recommendations which it urges should be carried out as soon as possible. Firstly, greater co-operation between the mine managements and the employees should be secured by works committees and joint committees following the lines laid down by the British Ministry of Labour; secondly, the rearrangement of underground work in order to increase the effective working period of natives without lengthening the time spent underground; thirdly, the experimental temporary employment of 5,000 natives from the north of 22° south latitude. The Commission is satisfied that the present sources of native labour are inadequate, especially in the event of industrial expansion, and is also satisfied that the use of Dr. Lister's pneumococcal vaccine and a general improvement in the hygiene of the mines have removed the reason for the present prohibition of the importation of these natives, namely, the high mortality previously experienced. The report makes no recommendation in reference to the question of retaining or abolishing the colour bar in the higher grades of labour, the Commission being of opinion that the total of natives employed will not be affected, whatever course is followed. The report further recommends the Government to require three months' notice of the intention to close down a mine, whereby the Government would be able to conduct an independent investigation into the matter.

A company called the South African Carbide & By-Products Co., Ltd., has been formed for the purpose of distilling coal and manufacturing carbide at the Ballengeich collieries, Natal. The process adopted provides for the coking of coal at a temperature which will ensure a yield of motor spirit, tar oil, and heating gas, together with a certain amount of ammonia. Some of the coke produced will be treated for gas manufacture and ammonia, and the remainder will be used in the manufacture of carbide. The amount of coal to be treated is 1,000 tons per week, and it will all be small and fine that is not suitable for steam-raising purposes. The company has a strong board and capable engineers, and a prominent underwriter of the issue of shares is the Johannesburg Consolidated.

Rhodesia.—The output of gold during August is reported at £207,339, as compared with £214,919 in July and £257,096 in August, 1918. Other outputs in Southern Rhodesia were : Silver 17,651 oz., coal 41,124 tons, copper 255 tons, asbestos 1,041 tons, arsenic 25 tons, and diamonds 46 carats.

Owing to the unfavourable results of operations during the last few months, the Antelope is to be closed down at an early date, as was intimated might be the case by the company recently. Notices to terminate the agreements with employees at the end of September were handed in at the end of August.

Nigeria.—The capital of the Rayfield (Nigeria) Tin Fields is to be increased by the issue of 100.000 10% preference shares of £1 each, bringing the capital up to £500,007. The purpose of the issue is to provide the necessary funds for the acquisition and development of new properties, and the extinction of debentures and income participation certificates. During 1918, the output of tin concentrate was 678 tons, a figure identical with that for 1917. The various properties contributed to this total as follows: Top 190 tons, Shen 174 tons, Old Shen and Lower Shen 93 tons, Delimi 97 tons, and Delimi No. 2 124 tons. Mr. J. M. Iles' report on the new properties acquired from the liquidator of West African Mines, Ltd., is exceedingly favourable. The company's profit during 1918 was £36,917, and £60,001 was distributed as dividends, partly out of the balance of profit brought forward from 1917.

The Toro company, one of the Keffi group, has recently acquired new properties adjoining those of the Lafon. The results so far are promising, and the directors are intending to issue new shares to provide working capital for development and plant. If the consent of the Treasury is obtained, 80,000 new shares of 5s. each will be created and offered for subscription to present shareholders.

Australasia.—The strike at Broken Hill continues. The miners are now asking Mr. W. M. Hughes to appoint a Federal Royal Commission to inquire into the Broken Hill mining industry.

The discovery of gold-ore deposits south of Kalgoorlie has attracted wide-spread attention in both England and Australia. Details are given in an editorial article elsewhere in this issue.

The Associated Gold Mines, at Kalgoorlie, was not able to make a profit for the year ended March 31, for while the yield per ton rose to 28s. 4d. as compared with 25s. 5d. the year before, the costs also advanced from 24s. 7d. to 27s. 4d. These costs did not include development, London expenses, or losses on realization of investments, so that the apparent profit is turned into a loss of £9,991. The amount of ore treated was 71,603 tons, and the yield £101,510. Very little development was done during the year, but the prospects are reported to be as good as they were a year ago. No estimate of reserves has been given for a number of years.

It is gratifying to be able to record a continuance of favourable developments at South Kalgurli Consolidated. The recently discovered No. 3 East lode is doing well on four levels, and large amounts of comparatively high-grade ore have been added to the reserve. During the year ended March 31, 126,828 tons of ore has been blocked out, and as a substantial proportion runs 10 dwt. per ton, the output and profits have been materially increased. The profit for the year was £10,205, obtained from the treatment of 96,239 tons yielding £128,556, and £9,375 has been distributed as dividend, being at the rate of 7½%.

India.—In the June issue it was announced that the Balaghat was to resume development. The directors have now formulated a plan for providing the necessary funds. A new company is to be formed with the same number of preference and ordinary shares as at present, but with the denomination 10s. instead of £1. The holders of the 95,400 preference shares will be given a similar number of new shares, and the 212,600 ordinary shares will be issued credited at 6s. paid. If all the shares are taken, the company will have £42,520 as working capital. The funds are required not only for actual development work but also to provide additional plant for conducting operations at depth.

Malaya.—The Chenderiang company reports for the year ended March 31 last an output of 169 tons of tin concentrate, obtained by dredging 890,000 cu. yd. of ground, and 81 tons from the hydraulic-elevating section and from tributers' work. The yield on the dredge was 0·44 lb. per yard. The profit for the year was £906. This disappointing result is due to a decrease in the yield per yard and substantial increases in working costs.

During the eighteen months ended December, 1918, the Kinta Tin Mines produced 742 tons of tin concentrate and made a profit of £85,738, out of which £36,000 was distributed as dividend, being at the rate of 30% free of income tax. A large sum had to be paid as excess profits duty. It is proposed to split the £1 shares into four of 5s. each. The company has largely participated in the reopening of the Tyndrum lead-zinc mines in Perth, Scotland, where production is now proceeding.

Cornwall.—The Jumbil Company, which, under Mr. Albert F. Calvert's control, is operating at Trevascus and other properties in the Gwinear district, made its first appearance at the Redruth tin ticketings on September 22. Two lots of 2½ tons each were offered, realizing £121. 5s. and £109. 15s. per ton respectively. As the average price of the 135½ tons offered at the ticketing was £144. 6s. 9d., it is clear that the Jumbil concentrate is not of first-class grade. This is no doubt due to the fact that the material treated comes from old dressing floors and dumps. It would be useful, as a guide to the value of this enterprise, to know how much material was treated in order to produce this 5 tons. As regards lode-mining, nothing has yet been done, the work in connection with the reopening of the workings being confined to making a clearance and sampling.

British Oil.—The bore at West Calder, Midlothian, sunk by Messrs. S. Pearson & Son, has reached sandstone containing free oil. There is not much flow so far. The Anglo-Persian's venture in connection with the consolidation of the Scottish oil-shale companies has been a success as far as the consent of the shareholders of the various companies is concerned, but labour troubles have arisen and the industry is idle. At one of the bores in Norfolk, sunk by the English Oilfields, Ltd., torbanite has been discovered in the middle of oil-shales. Torbanite is a variety of cannel coal and is richer in oil products than the shales.

Canada.—On another page Mr. Frank C. Loring gives a brief review of the present position at Porcupine. It is a remarkable circumstance that the Ontario ore deposits receive little or no attention in this country. The early attempts to interest English investors in Porcupine were failures, owing chiefly to the breakdown of negotiations between local owners and London financial houses. Cobalt also has been almost entirely neglected in London. The Kirkland Lake speculations have not been widely popular here, while such names as Matachewan, Boston Creek, West Shining Tree, and Gowganda are virtually unknown on the London market. We hope Mr. Loring's article will stir up some interest in Porcupine, and in Ontario deposits generally. Porcupine is an important gold camp presenting many opportunities, and the Hollinger is one of the great gold mines of the world.

The Mining Corporation of Canada announces that it has taken a four years' lease of the Foster property on Glen Lake, in the southern part of the Cobalt area. This property has been worked for some years, but additional rich ore is occasionally found, and there is a large reserve of low-grade ore.

Mexico.—The prospectus of the Sonora Mexican Silver Mines, Ltd., has been advertised this month. The company has been formed by Mr. T. W. Brown to acquire mines near the town of Minas Nuevas, in the district of Alamos, Sonora, that were worked before the Mexican revolution by Mr. Amos Yaeger. The Quintera, Zambona, and Purisima mines were reported on by Mr. W. Moulton Clarke, of Los Angeles, but the technical and political information contained in the prospectus is vague.

As mentioned last month, the Esperanza company has exercised its option on the properties of the Union en Cuale company's mines, in the State of Jalisco, Mexico. These mines have hitherto been worked for silver, but there is now the opportunity for dealing with the immense amount of complex sulphides, both rejected and still to be developed. Zinc predominates in the ore, and both lead and iron sulphides are associated, together with substantial amounts of silver and gold. In fact, the ore is characteristic of many Mexican mines. In the past only the richer ores could be treated, and the metallurgical difficulties were considerable. But with new methods of water-concentration and flotation, hydro-electrolytic processes, and chemical treatment, the problem should not be insurmountable.

It is stated that the Mexico Mines of El Oro, Ltd., has acquired the Lupita concession in the state of Jalisco.

Particulars are now available of the Mexican Corporation, recently formed by Mr. F. W. Baker to extend his many successful operations in North and South America. Other mining groups are associated with him in this new enterprise, and the board of directors includes Mr. R. T. Bayliss, chairman of the Exploration Co., Mr. Walter McDermott, chairman of Consolidated Mines Selection, and Mr. F. A. Govett, chairman of Lake View & Oroya Exploration. Substantial interests have been acquired in the Teziutlan Copper Co., which works complex sulphide ore in Pueblo, and in the Fresnillo Mining Co., which owns silver mines in Zacatecas. Part of the capital of the Mexican Corporation has been subscribed by the Camp Bird and Santa Gertrudis companies, and also by individual shareholders in these two companies.

The directors of the San Francisco Mines of Mexico announce that the option on the property given to an American group, as mentioned in our last issue, has not been exercised.

Bolivia.—The Porco Tin Mines company is considering the advisability of instituting a campaign of exploration at depth by means of the diamond-drill, and additional funds will have to be provided for the purpose. The company has not been a success so far, on account of the difficulty of maintaining a sufficiently great output, and the reserves are being depleted. During the last year or two, the mill has undertaken custom work, and efforts will be made to extend this side of the business. During 1918 the company treated 17,320 tons of its own ores, for a yield of 274 tons of concentrate averaging 61·8% metallic tin. The assay-value of the ore was 1·67%, and the percentage of recovery was 58·5. The reserve at the end of 1918 was estimated at 31,500 tons averaging 1·84% tin. The accounts for 1918 show a credit balance of £777, but the indebtedness to Messrs. Avelino Aramayo & Co. was increased by £7,813, making the total debt owing to this firm £57,202. The firm has exercised its right of conversion of the debt into debentures to the extent of £30,000. As regards the mill, with which some difficulty had been experienced, it is announced that the Marcy mill recently installed is giving excellent results. The question of the possibility of discovering ore at depth has been studied with exemplary care. Mr. H. A. Lewis, lately the manager, evolved a theory of the geology of the district, and Professor C. Gilbert Cullis, of the Royal School of Mines, was asked to report on the petrological and geological evidence. Mr. Malcolm Roberts, manager of the Aramayo-Francke Mines, was also called in, and it must also be remembered that Mr. Edward Hooper is chairman of the company, while Mr. A. B. Reece is the present manager, so there has been no lack of sound technical advice.

Colombia.—On several occasions we have referred to the new lode-gold property, known as the Constancia, acquired by the Oroville Dredging Co. A company called the Colombian Corporation has been formed, with a capital of £500,000, to acquire and develop this property. Half of the shares will be ordinary and will be allotted to Oroville Dredging as purchase price, and the other half will be preference, entitling holders to half the profits until 100% dividend has been paid, and thereafter entitling holders to a 12½% dividend. The preference shares will be offered for subscription to shareholders in the Oroville and Nechi companies. The corporation will undertake other mining business in Colombia in addition to working the Constancia mine.

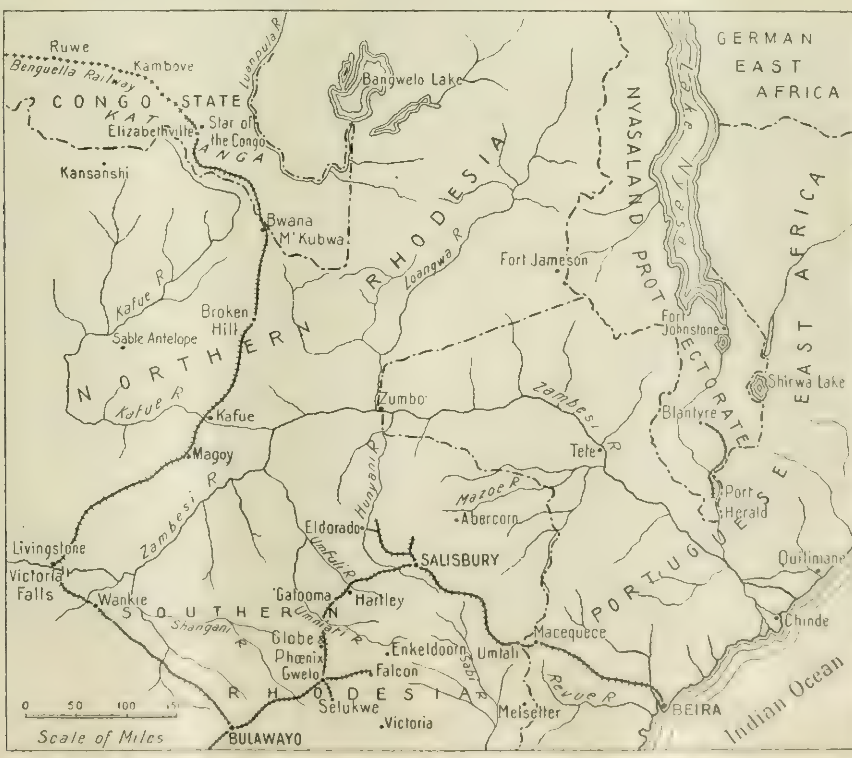
Spitsbergen.—Particulars are now available of the business of the Scottish Spitsbergen Syndicate, which was formed recently in Edinburgh to acquire estates in different parts of Spitsbergen, located by a series of expeditions from 1895 to 1909, conducted by Dr. William Spiers Bruce, the Arctic explorer. We cull the following from the statement circulated by the syndicate. These estates comprise about 1,650 square miles, or approximately one-twelfth of the whole Spitsbergen Archipelago. The expeditions located a large coalfield which extends over more than a 100 square miles between Klaas Billen Bay and Sassen Bay. Other minerals existing on the estates are gypsum, in large quantity, oil shale, and iron ore, the last-named being referred to by the syndicate as "possibly valuable." In July of this year an expedition, under the leadership of Dr. Bruce, with Dr. Rudmose Brown as second in command, was despatched to Spitsbergen. In the meantime Dr. Bruce has reported an important discovery of coal cropping out above sea level at Klaas Billen Bay. The seam contains over 6 ft. of coal, and within one square mile it is estimated by the geological specialists that there are 5,000,000 tons easily accessible.

THE LEAD-ZINC DEPOSITS
AT
THE RHODESIA BROKEN HILL MINE, NORTHERN RHODESIA.

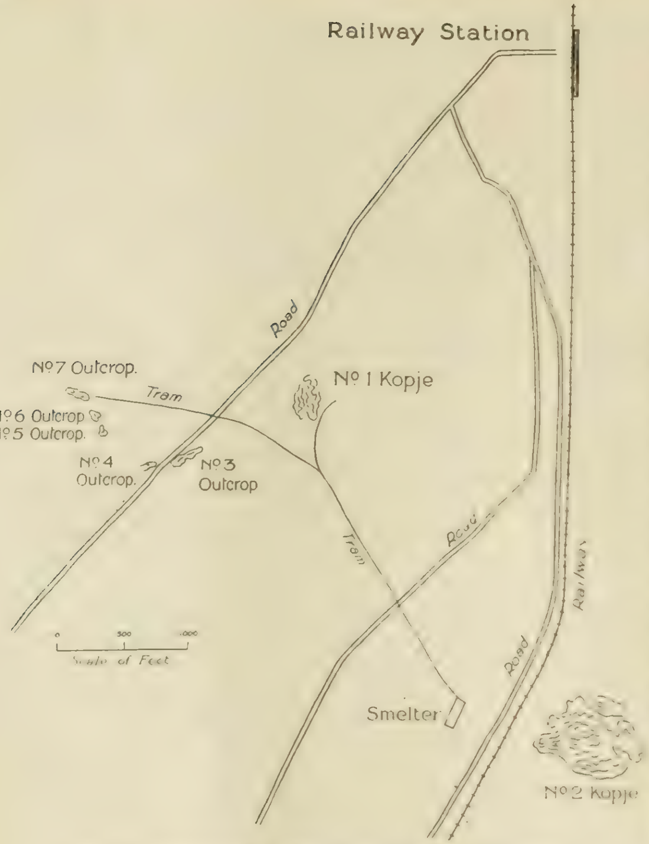
By S. J. SPEAK, A.R.S.M., M.Inst.M.M.

These deposits consist on the surface of oxidized ores of lead and zinc, while bore-holes have proved the existence of sulphides at depth. At present the leady portions are being smelted and the output of metallic lead is about 1,200 tons per month. The smelting plant is being extended so as to double the capacity.

HISTORY.—After a dozen or more years of difficulties caused by high cost of transport and fuel and by the nature of the metallurgical problem, the lead-zinc ore deposits at Broken Hill in Northern Rhodesia are now being worked successfully on a commercial scale. The deposits were discovered in 1902, and the Rhodesian railway reached the district in 1906. During the latter year a considerable amount of rich zinc ore was shipped and the two chief outcrops were developed down to water-level. Nothing came of this pioneer work, and from 1907 to 1913 inclusive, the mines were idle. In 1914 a small plant was erected with the object of producing a rich lead concentrate by means of the Murex magnetic process and smelting this concentrate in a blast-furnace. Many engineers had previously visited the property and had agreed that it was impossible to smelt the ore direct in a blast-furnace. In 1915 I discovered that the deposit at No. 1 kopje outcrop could be mined in such a way as to give two classes of ore, one of them rich enough in lead and low enough in zinc for smelting, and the other too high in zinc. At the time the Murex process became impossible owing to the high war price of oil. Smelting of the rich lead ore was commenced in 1915 in a small circular blast-furnace, and this was continued during 1916 and the early part of 1917. In June, 1917, two new furnaces, each 44 in. by 190 in., were put into operation, and in 1919 plans were laid for building two more furnaces of the same type.



MAP OF RHODESIA SHOWING POSITION OF BROKEN HILL.



PLAN OF THE RHODESIA BROKEN HILL COMPANY'S PROPERTY.

The following table gives the monthly statistics of the output of lead since the start :

	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	—	72	80	949	587
February	—	137	100	812	8 6
March	—	77	108	666	1085
April	—	139	141	1044	1202
May	—	122	104	1085	1221
June	31	121	117	1078	1346
July	80	57	412	1035	1219
August	81	80	478	801	1089
September	37	110	520	962	1028
October	34	132	588	729	—
November	106	108	648	nil	—
December	109	89	525	nil	—

THE COUNTRY.—Broken Hill is situated at a height of 3,879 ft. above sea level. The country is very slightly rolling. In the low parts there is grass, and often vleis, while the other parts, constituting about two-thirds to three quarters of the whole, are lightly timbered with trees mostly under 12 in. diameter. As already mentioned, the cost of transport delayed development. Broken Hill is 1,330 miles from Beira, 443 miles from the Wankie Colliery, and 2,013 miles from Cape Town. The route to Beira is roundabout, and a line already surveyed, from the railway south of Broken Hill to the westerly spur from Salisbury, would reduce the distance to 815 miles.

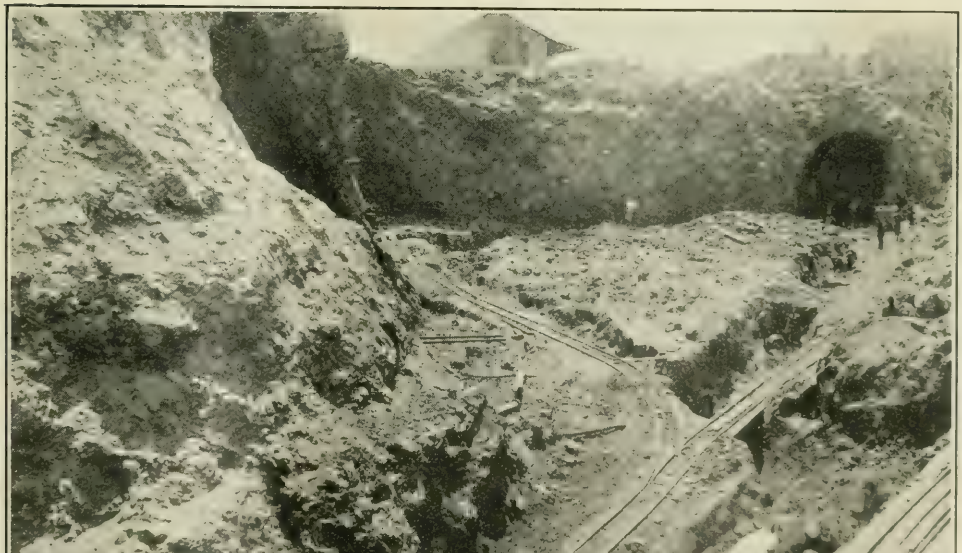
The rainfall at Broken Hill varies from 25 to 45 in. per year, and the rainy season is from November to March inclusive. A troublesome feature is the presence of the tsetse fly, which in recent years has entered the district, making it impossible to employ draught animals.

THE DEPOSITS.—The rocks of this part of Rhodesia are classed by Mr. A. J. C. Molyneux, of the Rhodesian Geological Survey, as Archean, and for miles round Broken Hill they consist of dolomite and dolomitic schists, which trend NE—SW. There are numerous outcrops, the two most important being Nos. 1 and 2 kopjes. No. 1 kopje is apparently in dolomite, and No. 2 is in dolomite on the south and in schist on the north. There is much evidence that this band of schist ceases abruptly in the direction of No. 1 kopje, but extends some miles eastward. The extent and dimensions of the ore-bodies can be judged by examining the plans, cross-section, and photographs accompanying this article. As regards the ore minerals, the lead occurs as carbonate and rarely as sulphate, while the zinc occurs as silicate and rarely as carbonate. Gold is absent, and silver rarely exceeds 1½ oz. per ton. Phosphates, vanadates, and, in a minor degree, arsenates also occur, there being about ½% of V_2O_5 in the ore. The bore-holes below water-level prove the presence of sulphides in depth. A tentative hypothesis of the origin of the ores is as follows: There are two systems of fissuring, having the directions E—W and NW—SE respectively. Where these cross large ore-bodies have been formed. No igneous rock is found within miles. The solutions evidently contained only zinc, lead, sulphur, silica, iron, phosphorus, vanadium, and a little arsenic.

The surface soil and detritus in the vicinity of the ore-bodies usually extend to water-level. The outcrop of the ore-bodies, as already mentioned, exist as kopjes, and are so much leached and collapsed that their true nature is obliterated. No doubt the ore was originally sulphide. The effect of water on it was to leach out zinc preferably to lead, and the zinc sulphate formed attacked the surrounding dolomite.

The following table gives the averages of

PORTION OF NO. 1 KOPJE.



VIEW OF OPEN-CUT LOOKING NORTHWARD.

Practically the whole of the bottom of the quarry is in ore suitable for direct smelting for lead; the walls are too zinciferous for such method of treatment.

analyses of the ore at Nos. 1 and 2 kopjes. These are averages, and the figures vary within wide limits, as will be seen later when describing the boring campaign. Also it must be remembered that the figures do not relate to the ore now being smelted:

	No. 1. Kopje. %	No. 2 Kopje. %
SiO_2	13·63	15·30
PbO	30·15	2·40
ZnO	24·63	31·16
CuO	0·10	0·06
Fe_2O_3	15·27	41·96
FeO	1·39	0·85
MnO	trace	trace
Al_2O_3	3·03	4·24
CaO	trace	trace
MgO	0·18	0·25
P_2O_5	2·07	1·04
S	0·20	0·10
As_2O_3	trace	trace
CO_2	5·97	trace
H_2O	3·44	2·76
	100·06	100·12

MINING PROBLEMS.—When regular mining was started at No. 1 kopje, an attempt was made to sink a shaft in order to reach the unweathered ore. The water immediately caused trouble. The water-level is 15 to 18 ft. below the surface, according to the season. The shaft at a depth of 29 ft. made water at the rate of 100,000 gallons per hour. The shaft had not reached the solid dolomite, but the last few feet contained some boulders of dolomite. It was then decided to suspend sinking until the ground surrounding the shaft had been impregnated with cement, which work is now in hand. Meanwhile all the ore for the smelter is obtained by open-cut. A depth of 34 ft. below ground level has now been reached in the quarry, and pumping is going on at the rate of 100,000 to 180,000 gallons per hour. This pumping is having the effect of reducing the water-level in the surrounding country. It is not yet possible to estimate how much water will have to be pumped after the surrounding country is once drained. In my opinion, the fact that the water-level is nearly constant after a dry season of seven or eight months of the year indicates the difficulty the water experiences in sinking into the solid dolomite. Within thirty miles there is an escarpment with over 1,000 ft. drop, and if the main body of the dolomite were full of channels the water would soak away and not remain steady as it does. Any lake must have a good bottom if it will hold water steadily. Hence there are expectations that below a depth of 100 ft., where the corrosive effects of surface waters will probably cease, the ground will not be watery.

EXPLORATION.—In order to explore in depth, a systematic boring campaign was inaugurated in 1918. At No. 1 kopje seven bores have been put in, the positions being marked on the plan, while another bore was made at No. 3 kopje. Owing to the friable and vughy nature of the ground, it had been found previously that very small amounts of core were obtained by diamond-drill, so shot-drills giving 6 in. cores were adopted. Even with these drills little core is obtained in the oxidized ground, and reliance has to be placed largely on the sludges. No doubt in the earlier work much ore was passed through without the operators knowing. The failure of a drill-hole to disclose ore cannot be accepted as evidence of non-occurrence of an ore-body; all it can do is to indicate that the ore-body is not large.

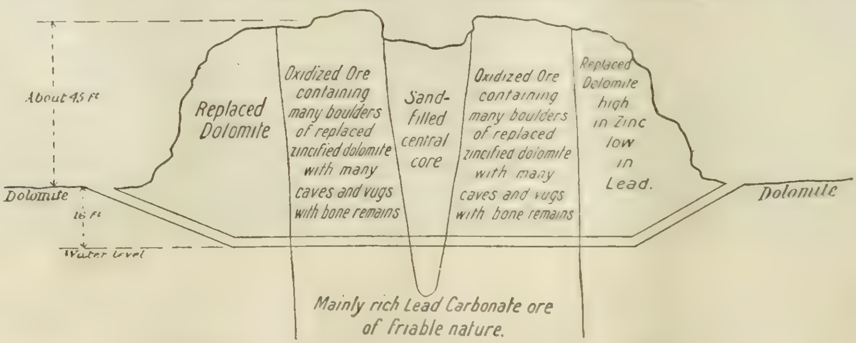
At No. 1 kopje, three bores, A, A1, and A2, were started at a point in the south-east, but at different inclinations, dipping at 71½°, 55°, and vertically respectively. The following tables give the results:

BORE-HOLE A.

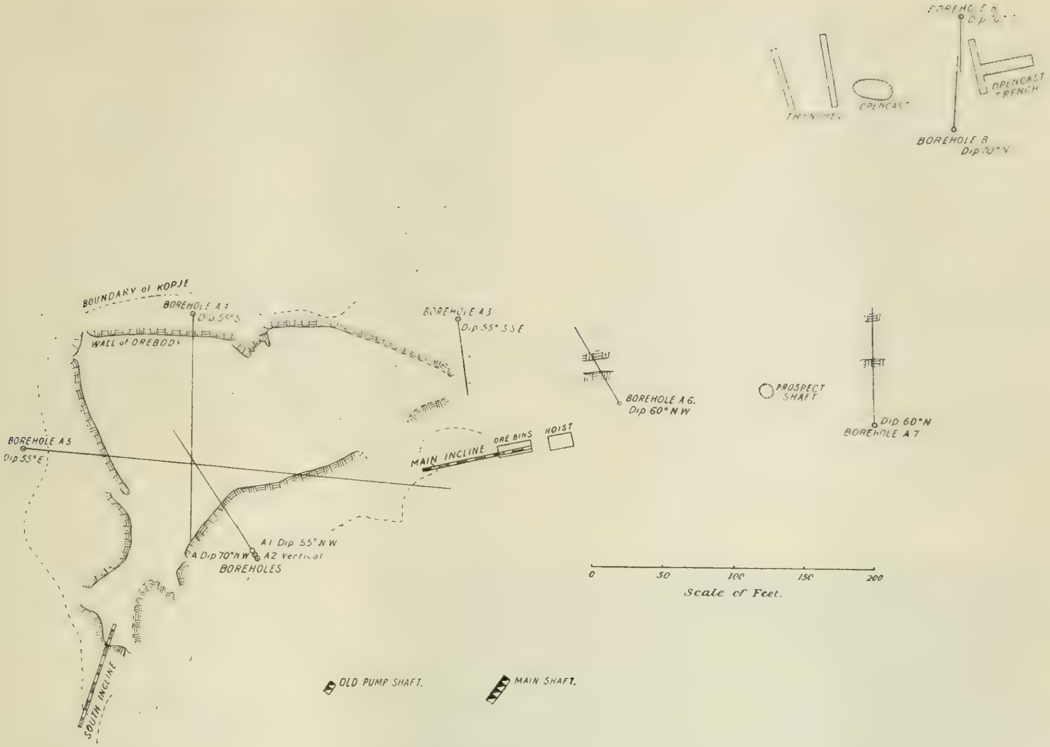
Dipping at 71½°.

Depth Ft.	Ft.	
0 to	48	Dolomite.
48 ,,	61	Zinc carbonate, 42% Zn.
61 ,,	75	Ferruginous quartzite with small quantity of lead carbonate, galena, and blende; 11·4% Pb, 31% Zn.
75 ,,	108	Mostly zinc silicate, with some sulphide, and a small quantity of lead carbonate; 10% Pb, 30% Zn.
108 ,,	126	Quartzite with some zinc silicate; 9% Pb, 13% Zn.
126 ,,	189	Sulphides; 30% Pb, 24% Zn
189 ,,	228	Oxidized zinc ore; 4% Pb, 30% Zn.
228 ,,	364	Dolomite; stopped boring at 364 ft.

Total oxidized zinc ore = 117 ft averaging 28¾% Zn.
Total sulphides = 63 ft. averaging 30% Pb and 24% Zn.



DIAGRAMMATIC VERTICAL SECTION OF No. 1 KOPJE.



PLAN SHOWING POSITION OF BORE-HOLES.

BORE-HOLE A1.

Same Vertical Plane as A, but Dipping at 55°.

Depth Ft.	Ft.	
0 to	40	Dolomite.
40 „	48	Zinc carbonate; 47% Zn.
48 „	62	Zinc quartzite; 9% Pb, 24% Zn.
62 „	85	Lead carbonate, zinc silicate; 22% Pb, 11% Zn.
85 „	110	No core; sludges ran 31% Pb, 3% Zn.
110 „	139	Lead carbonate sludges; 59% Pb, 1% Zn.
139 „	140	Lead sulphide, lead carbonate, zinc silicate; 34% Pb, 16% Zn.
140 „	155	Silicious zinc ore; 11% Pb, 7% Zn.
155 „	163	Zinc silicate ore; 9% Pb, 26% Zn.
163 „	170	Patches of zinc carbonate in dolomite.
170 „	201	Dolomite; stopped boring at 201 ft.

BORE-HOLE A2.

In same Vertical Plane as A and A1, but Vertical.

Depth Ft.	Ft.	
0 to	54	Dolomite.
54 „	78	Zinc silicate; 7% Pb, 33% Zn.
78 „	106	Zinc silicate and lead sulphide; 21% Pb, 25% Zn.
106 „	116	Lead and zinc sulphides; 10% Pb, 42% Zn.
116 „	125	Lead sulphide; 58% Pb, 15% Zn.
125 „	135	Lead and zinc sulphides; 32% Pb, 38% Zn.
135 „	140	Zinc carbonate; 52% Zn.
140 „	314	Dolomite; stopped boring at 314 ft.

BORE-HOLE A3.

Outside the Kopje at the North-East Corner.

Passed through ferruginous rock for 79 ft. and then entered dolomite, revealing no ore.

BORE-HOLE A4.

Driven South from the Mid-North of Kopje, Dipping 55°.

Depth Ft.	Ft.	
1 to	13	Ferruginous ore; 14·6% PbO, 10·5% Zn.
13 „	38	Chiefly zinc carbonate; 1½% PbO, 56·1 ZnO.

Continued.

Depth Ft.	Ft.	
38 „	41	Ferruginous lead carbonate; 24·6% PbO, 7·7% ZnO.
41 „	57	Sludges only; 53·5% PbO, 4·3% ZnO.
57 „	67	„ 58% PbO, 1·3% ZnO.
67 „	82	„ 63·2% PbO, 1·4% ZnO.
82 „	97	„ 53·3% PbO, 1% ZnO.
97 „	112	„ 61·1% PbO, 1·9% ZnO.
112 „	116	„ 62·7% PbO, 2·2% ZnO.
116 „	128	„ 64·8% Pb, 1·1% Zn.
128 „	158	„ 3·7% Pb, 26·6% Zn.
158 „	162	„ 35·4% Pb, 23·2% Zn.
162 „	182	Sulphides; 46% Pb, 26·6% Zn.
182 „	204	„ 31% Pb, 33·2% Zn.
204 „	209½	„ 14·9% Pb, 41·7% Zn.
209½ „	221½	Silicious ore; 1% Pb, 15·5% Zn.
221½ „	232	„ 2·4% Pb, 15·8% Zn.
232 „	243½	Zinc carbonate 50·5% Zn.
243½ „	264	Dolomite.

BORE-HOLE A5.

Driven from the West of No. 1 Kopje, Dipping 55° to the East.

Depth Ft.	Ft.	
0 to	40	Ferruginous zinky material.
40 „	62	Ferruginous zinky material with small quartz veins: 18% Pb, 18% Zn.
62 „	91	Lead carbonate sludges; 52·8% Pb, 6·7% Zn.
91 „	138	Mixed oxidized ores; 26·8% Pb, 25·6% Zn.
138 „	161	Sulphide ore; 43% Pb, 23% Zn.
161 „	198	Mixed oxidized ores; 20·6% Pb, 20% Zn.
198 „	264	Sulphide ore; 42% Pb, 24·5% Zn.
264 „	276	„ with some zinc silicate; 25·7% Pb, 32·5% Zn.
276 „	286	Hematite, with zinc silicate; 10·6% Pb, 20·5% Zn.
286 „	315	Zinc silicate, with lead carbonate and galena; 21·4% Pb, 39% Zn.
315 „	385	Zinc silicate; 4·4% Pb, 45% Zn.
385 „	403	Sulphides, with some oxidized ore; 28% Pb, 31·8% Zn.
403 „	415	Zinc silicate; 8% Pb, 38% Zn.

Survey of hole: At 100 ft., 5[illegible]°; 160 ft., 46°, 240 ft., 35°; 320 ft., 24°; 400 ft., 16°. This makes the 400 ft. point 250 ft. vertically below the point of starting and 300 ft. horizontally away.

BORE-HOLE A6.

At a Point 100 ft. East of A3, and Dipping 60° NW.

Depth Ft.	Ft.	
27½	to 40	5·3% PbO, 39·6% ZnO.
40	„ 56⅔	8·7% PbO, 48·8% ZnO.
56⅔	„ 72	30·2% PbO, 35·7% ZnO.
72	„ 87	8% PbO, 48·1% ZnO.
87	„ 105	4% PbO, 30·2% ZnO.
105	„ 126	Dolomite.

BORE-HOLE A7.

Still Farther to the East, Dipping 60° N.

Depth Ft	Ft.	
90	to 95	Chiefly dolomite; 1·2% PbO, 16·1% ZnO.
95	„ 103	14·5% PbO, 51·3% ZnO.
103	„ 106	Cavity.
106	„ 116	Clay.
116	„ 125	Loose ground cemented; 3·2% PbO, 29·4% ZnO.
125	„ 140	Lead and zinc carbonate and vanadate; 24·4% PbO, 31% ZnO.
140	„ 146	Lead and zinc carbonate and vanadate; 26·9% PbO, 30·4% ZnO.
146	„ 147½	Sulphides; 25% PbO, 47·7% ZnO.
147½	„ 150½	Fractured dolomite; 0·6% PbO, 15·4% ZnO.
150½	„ 153	Zinc carbonate; 0·7% PbO, 58·4% ZnO.
153	onward	Dolomite.

The above information relates to the bore-holes on No. 1 kopje, which contains the deposits now being worked. In the following paragraphs and tables the results of development at other outcrops are given.

At No. 2 kopje, cross-cuts and drives at surface level show: Length proved 400 ft., maximum width 80 ft., average contents 32% Zn and 2% PbO.

At No. 3 kopje, the zinc contents again predominate. The cross-cut south from the main shaft at a depth of 25 ft., near the middle of the kopje, gave the following assay-values, at intervals of 5 ft. from 0 to 70 ft.: 32% Zn; 20% Zn; 31% Zn; 36% Zn; 47% Zn; 31% Zn, 10% Pb; 28% Zn, 10% Pb; 9% Pb; 24% Zn, 9% Pb; 35% Zn, 9% Pb; 28% Zn, 17% Pb; 35% Zn, 5% Pb; 28% Zn, 8% Pb; 24% Zn, 6·5% Pb.

The east adit, 0 to 65 ft., averaged 30·5% Zn, and the west adit, 0 to 55 ft., averaged 22% Zn.

VIEW OF DRAIN AT N.W. CORNER OF OPEN-CUT.
The wall in the distance consists of replaced dolomite which is too zinciferous for present treatment.

A bore-hole from the south side of the kopje opposite the shaft was sunk with a dip of 55° and gave the following results:

Depth Ft.	Ft.	
25	to 53	Dolomite.
53	„ 74	Bands of zinc silicate and iron oxide.
74	„ 98	Zinc silicate, lead carbonate, with streaks of sulphides; 23% Pb, 27% Zn.
98	„ 101	Zinc silicate; 12% Pb, 40% Zn
101	„ 116	No core; 23% Pb, 27% Zn.
116	„ 137	Dolomite.
137	„ 149	Zinc silicate; 7% Pb, 34% Zn.
149	„ 153	1% Pb, 52% Zn.
153	„ 165	Dolomite.

On No. 4 kopje, a trench gave 3 to 4% Pb and 5 to 28% Zn across 40 ft.

On the No. 5 kopje, a trench gave 2 to 31% Zn and traces of Pb across 45 ft.

In the north-west corner of the concession an outcrop of gossan is visible over a small area; a shallow trench has disclosed nothing definite, but evidently a mineralized zone occurs.

METALLURGY.—As already mentioned, the blast-furnaces treat picked ore high in lead. The slags average about 19% SiO_2, 45% FeO, and 18 to 20% ZnO, and they are liquid even with 25% ZnO. The chief points of the success in treating a charge so high in zinc are the low blast pressure (about 8 oz.) and the slow rate of smelting (about 130 tons of charge per day per furnace). The blast is supplied by fan blowers. The depth from the charging floor to the base of the crucible is 19 ft. A special top takes the smoke from the centre and feeds down the sides of the furnace. The slag runs continuously. Fine ore is sintered on hand-operated grates. Nothing worthy of the name of an ore-bedding system has as yet been inaugurated, nor any system for slag-handling, owing to difficulties arising from the war, but these questions are now being taken in hand. Fluxes are obtained within a mile of the furnaces. Ironstone comes from an ore-body which shows signs of passing into pyrites in depth. Local dolomite is used to a slight extent. The coke comes from the Wankie Colliery.

The problem of extracting the zinc from the oxidized ores remains to be settled. Altogether there exists probably over a million tons of oxidized ores containing about 35% of zinc cum lead, which owing to local conditions will require special processes of treatment. Probably more than one method will have to be adopted. It is hoped to produce a certain amount of zinc oxide for sale as a pigment. It seems probable that the electrolytic method will be preferable to distilling, for water power is available for the generation of current, and the necessary acid can be made from sulphides.

The specimens of sulphide ore obtained by drilling show a coarse crystallization, and possibly the galena and blende therein can be effectively separated by water-concentration alone; no special difficulties are therefore expected with them.

JOURNEYS IN RUSSIA.

By Dr. A. L. SIMON.

The author continues his account of war experiences in Russia and tells of coal mines in South Russia and near Irkoutsk, and salt mines in Turkestan.

IN the April issue of the Magazine I gave an account of conditions in the coal mining district of South Russia during the early days of the war.

In December, 1915, I returned from the Donetz coal district to Petrograd. Here I found speculation in shares, properties, and goods at fever pitch. All kinds of properties were being offered for sale, with fantastic tales as to their merits. From January, 1916, until the days of the revolution in March, 1917, I visited and reported on numerous mining ventures, which, in the majority of cases, proved to be valueless. Some of these are mentioned in this article, in order that colleagues may possibly be saved the trouble of visiting them in days to come. Others are mentioned in order to expose absurd claims. But some of the properties I saw are valuable and will doubtless play an important part in the future industrial development of Russia.

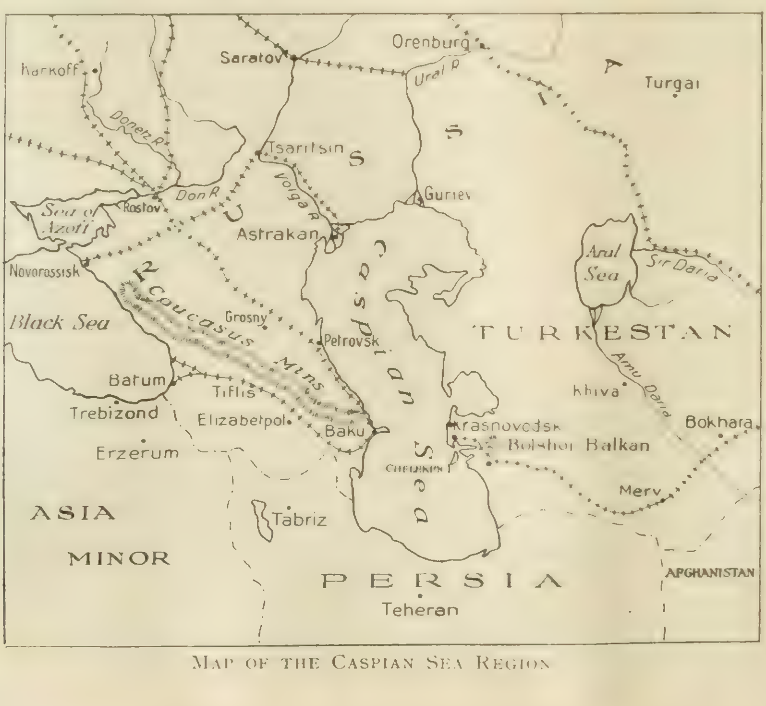
Travelling conditions, which had gone from bad to worse, were typical of the general disorganization. All trains were over-crowded, and seats were obtainable at short notice only by judicious tipping. The tip eventually found its way to the booking clerk, but the difficulty consisted in finding the confidential intermediary for a transaction which had to be sufficiently complicated to obliterate any trace of bribery. The confidential intermediary could generally be discovered through the chief railway porter or a hotel clerk. When everything else failed, the tendering of a gold coin in part payment of the ticket was an infallible means of securing accommodation at the shortest notice. Shortly after the revolution, travelling conditions became worse still, the throng of passengers being augmented by soldiers of all grades, mostly deserters wanting to get home at any price. This type of soldier was the fore-runner of Bolshevism, and all attempts to cope with such an unruly element proved inadequate and fruitless. They sought accommodation anywhere, in the compartments of other passengers, in the passages, the lavatories, and even on buffers were they to be found travelling. On one occasion, just outside Petrograd, eighteen soldiers who had selected the roof of the railway carriage were brushed off by a low bridge and killed. On another occasion, the train was not travelling fast enough for their taste, and, after arguing at a stopping place with the engine-driver and fireman, they pushed the latter alive into the fire-box so that he might in that way assist the train to accelerate speed. Numerous deeds committed by these runaways are so ghastly and terrible as to be hardly believable.

The first property I visited in 1916—a colliery in the Donetz basin, with an area of some 8,000 acres—had four proved coal seams of good quality. The owners, in anticipation of property confiscation and "soviet" rule, were anxious to sell to a non-Russian, as it was surmised that foreign ownership would be respected. The property was acquired by a foreign syndicate, but its ultimate fate is not yet known.

The next properties visited were situated in Russian Turkestan, about 60 miles to the east of Krasnovodsk on the east side of the Caspian Sea, opposite Baku, one a hypothetical coal mine, the other a salt deposit. The coal mine was of the opera-bouffe type. It had been much talked about in Petrograd. It was stated that the coal was being sold locally at £6 a ton, that it yielded a magnificent coke, and, being close to the Caspian Sea, could readily be shipped to Tsaritsin on the Volga, 150 miles from Astrakan, so that with magnetite from the Urals the elements for a large new iron industry were at hand. A capital of two million pounds was considered sufficient for a start, and it was being debated whether the coal should be transported to Tsaritsin in steamers or in barges. My inspection of the coal mine showed it to contain a seam of brown coal 22 in. thick, with at the most 60,000 tons of reserves. The seam occurs in flat-topped foot-hills of a most interesting mountain, the Bolshoi Balkan. These foothills are cut into by numerous ravines, which also intersect the coal seam and gave the means of arriving at an estimate of reserves.

The Bolshoi Balkan is a table mountain which rises from the flat desert to the east of the Caspian and constitutes a real mountain oasis in that desert. The approaches are ragged, rocky, and barren; the interior, however, is wooded, with animal life. I saw the skins of large leopards and foxes, which the natives, the Tourkomans, bring to Djebel as results of their hunting expeditions. The western slope of the mountain is well watered, and was formerly used by the natives for agricultural pursuits. Since the building of the Trans-Caspian Railway, most of these natives had to leave, as their water supply was requisitioned by the railway administration. A pipe-line some twenty miles long delivers the water from the catchment areas to the railway station of Djebel, from where it is sent in wooden tubs by rail both to Krasnovodsk, sixty miles to the west, and for a similar distance to the east. The pipe line is guarded by a detachment of Russian soldiers; nevertheless, it is constantly tampered with by the old natives, who only see in it an interference with their natural rights.

The salt deposit of Molla Kara is situated about three miles to the south of Djebel, with which it is connected by rail. Molla Kara is named after a small salt lake deriving its water from a hot spring of some 160°F. situated in the central part of the lake. The salt water is extremely dense, the human body cannot sink in it, and it is said to be possessed of unequal-

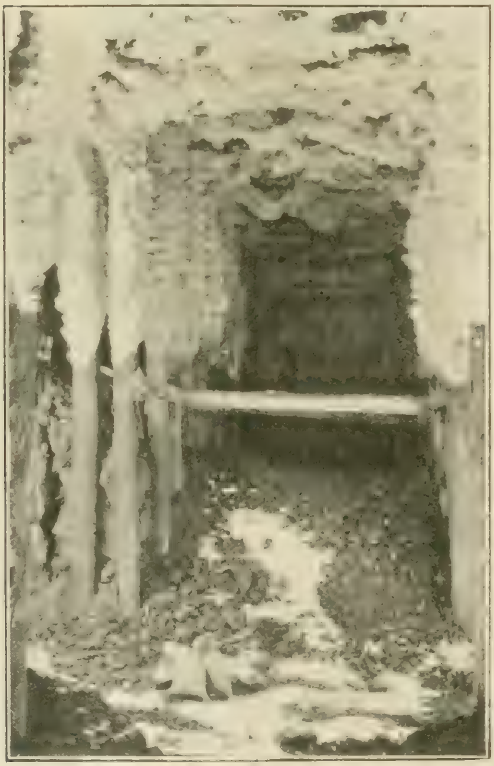


MAP OF THE CASPIAN SEA REGION

Village of Golovinskaia, Siberia.

led curative powers. The lake and spring are owned by the Trans-Caspian railway administration and are being used as a sanatorium for their employees. Extensive buildings surround the lake; they are of the military hospital type, with wards, cubicles, mess-rooms, entertainment-hall, band-stand, and doctors', nurses', and attendants' quarters. During the summer season, from April to October, every available space in the establishment is filled by patients suffering from skin, rheumatic, and other diseases, and the cures said to have been effected are well-nigh incredible. The treatment consists of mud packs, mud baths, and hot salt water baths, all of which are followed by tepid fresh water showers and, in the rheumatic cases, by massage. In the mud-pack treatment, the patient is placed on a low, wheeled, wooden platform, and covered all over with a thick layer of freshly dug black mud. His face and head emerging from the clay-like coating of the body give him the appearance of a mummy, only a live one. The platform is then wheeled on to a boarded floor space and exposed to the sun, the head and face being screened. The time of exposure to the sun's rays varies from a quarter of an hour to an hour or more; the baking operation is followed by a plunge bath and shower. It is stated that the great healing properties of these waters are due to the presence of radium, particularly in the black mud. The lake is bordered on the east by loose sand banks, or dunes; it changes into reed-covered mud flats on the south and south-west, while to the west and north-west it merges into a reddish sand plain many square miles in extent and bordered in the distance by low loose sand-hills. The sand plain proper, below a thin layer of loose sand, consists of a caked reddish material 8 to 10 in. thick, below which a layer of from 3 to 4 ft. of perfectly white salt is to be found in a dense brine. During the winter months, December to March, the water rises, covering the plain in patches and rendering it inaccessible for exploitation purposes. From May onwards the water recedes to below the caked surface layer, and during these months exploitation is in full swing. All the work is carried out by small contracting parties, generally Khirgize, and consists in first clearing a patch of salt by removing the caked surface layer and stacking it on one side of the clearing. They then make a hole in the salt layer, using crow-bars and dippers for that purpose; this hole, measuring about 3 by 4 ft., always remains partly filled with brine. When of sufficient size to admit of a special dipper, the salt layer is broken down with crow-bars into the hole, and this loose material is dragged to the clean surface with the special dipper, it being handled like a drag bucket. The large lumps thus raised are broken up with mallets, and the crushed material is pushed back into the brine for rinsing purposes. When sufficiently fine-grained, it is heaped for a short period on the salt crust, and is then transported in wheel-barrows or trucks to a sandy patch on the lake shore where it is stacked for curing.

The salt as raised from the brine well contains varying amounts of sodium sulphate and magnesium chloride, which must both be eliminated before it is fit for household or preserving purposes. Sulphate of soda is a strong aperient, while magnesium chloride, besides being bitter, is hygroscopic, and causes fish preserves to turn black. The elimination of the deleterious salts is effected by the action of rain on the salt stacks. Rain, however, is scarce in Trans-Caspia, and salt stacks may have to remain exposed to atmospheric treatment for three, four, or more years. When sufficiently purified for market purposes, a shrinkage of 10% of the originally stacked heap has taken place. The uncertainty as to the length of the purifying period is a serious drawback to this salt industry, and has been the cause of many financial failures. The purifying of the salt stacks represents cash outlay for wages and government dues, and if they become marketable a year or more later than anticipated the enterprise necessarily becomes insolvent unless backed by a reserve fund two or three times as large as the annual turnover.



ICE IN A SIBERIAN COAL MINE

When the salt in the heap is considered sufficiently purified it is broken into and the caked salt sent to a mill, where it is ground in different kinds of pulverizers or grinders and graded in either revolving or shaking screens. The finished product is despatched, either in bulk or in casks, sacks, or paper packings.

The Molla Kara salt mill has been built at Djebel railway station, the cured coarse salt lumps being brought from the lake shore to the mill on camel back.

All salt produced in Russia is subject to a government tax. This is levied on 90% of the raw salt heap, 10% being allowed for shrinkage, and must be paid before the salt can be sent to the grinding mill. The control exercised by the State over salt production was very strict, and each salt mine, besides a district controller, was saddled with a local controller, who, being insufficiently paid by the State but invested with terrifying powers, had to be kept good-tempered by judicious monetary subsidies.

A much larger salt deposit with similar features to the one described was visited on my return journey. It is situated at Kuli, on the shores of the Caspian Sea, some six miles north of Krasnovodsk, and was suffering at the time of my visit from an accumulation of stocks insufficiently cured with resulting deficiency in ready cash

This journey was succeeded by an extensive journey east, the first objective being a coal mine situated near the railway station of Golovinskaya on the Trans-Siberian, some ten miles west of Irkoutsk. On my arrival there toward the end of March, 1916, the country was still under snow and ice. The mine, which has been extensively opened up, boasts of a coal seam 15 ft. thick, consisting of alternating layers of workable brown coal and slate. The former workings were accessible through an adit. The upper part of the old timbers, as well as the roof of the drives, were all thickly covered with ice crystals and gave this mine much more the appearance of Aladdin's cave as Doré would have pictured it than of a coal mine. There are, however, in the neighbourhood much better coal mines that can produce coal cheaper, and there being only one serious consumer, the railway, prices had to be on the level of the cheapest producer, so that the mine referred to had to shut down.

The railway line from Golovinskaya to Irkoutsk passes through the chief coal-producing centre of Central Siberia at Cheremkovo. Coal mining in that locality is very active, and supplies the fuel to the Krasnojarsk-Irkoutsk section of the Trans-Siberian railway, and also to a small porcelain factory and an iron foundry.

On arrival at Irkoutsk railway station on April 13, 1916, it was found that the river Angara, which flows between the railway line, following its left bank, and the town of Irkoutsk, situated on the right bank thereof, was about to break up. It was stated that a horse and cart had broken through the ice the day before, in consequence of which the police were guarding the river approaches and prohibiting all traffic across the ice. After much trouble sleeping accommodation was secured near the railway station in an establishment letting furnished rooms. They were certainly record rooms as far as dirt is concerned, and they were well furnished with a particularly large variety of Siberian bed-bugs, blood-thirsty animals, which were, however, checked by the camp bed. This it is always advisable to carry, in order to ward off creeping insects. Its legs should stand on small squares of parchment paper strewn with insect powder, and to guard against the winged variety as well it should be provided with a mosquito net hung between four sticks, the lower end of the net being well tucked in under the bedding. After two days' waiting the ice broke, and communication with the town shore was established by small steamers.

Irkoutsk has a population of some 60,000. It is the residence of the Governor General of Siberia. It has a fine cathedral, numerous other churches, a large opera house, and Government buildings for the Trans-Baikal Railway Administration, the Post and Telegraphs, the Military Police, Revenue, and other Administrations. Nevertheless there is no bridge across the Angara, and thereby hangs a tale.

While the river is free from ice a pontoon bridge establishes the communication from bank to bank; when frozen, the ice carries the traffic. A fortnight or three weeks before ice sets in, the pontoon bridge is removed to safe winter quarters, and after the ice is gone it takes from three to four weeks to put the pontoon bridge again into position. The bridge is the property of the town of Irkoutsk, but its removal and re-establishment are in the hands of a contractor who receives in payment all the toll-takings for wheeled traffic over the bridge, out of which takings he has to pay to the town of Irkoutsk an annual sum of 100,000 roubles. Foot passengers cross the bridge free of charge. During the two interim periods, in the autumn and spring, when there is neither bridge nor ice, communication for passengers is effected by two small steamers against payment of ½d. per head. The contractor's takings during those two periods are sufficient to pay for all his expenses, including the 100,000 roubles to the town, so that all the toll-takings for wheeled traffic over the bridge are clear profit, large enough to enable him to give to the influential town councillors substantial yearly cash presents. Why therefore should they vote for a permanent bridge? The railway administration several years ago informed the town council that unless a permanent bridge were built within a specified time all Government offices would be moved to the left bank of the Angara. Thereupon things began to hum. Plans were prepared and approved of by the Administration of Roads and Bridges. The contractor in the meantime paid a visit to St. Petersburg, as a result of which the War Ministry decided that the bridge, as contemplated, was unfit for military purposes and condemned the design. New tenders had to be called for, while a fresh lease of life had been given to the pontoon bridge, and, thus, to the private income of certain town councillors.

FOUR YEARS AS A PRISONER OF WAR

By J. C. FARRANT.

(*Concluded from the September issue, page 159*).

October. The news from the west front continued to improve, and maps were brought out from hiding places, and the advancing line was marked daily.

November 8. Delegates crossed the line for conditions of Armistice from Foch. Democrats and socialists delivered ultimatum that the Kaiser and his son must go. Boys flogging spare gear.

November 9. A day which will ever be remembered in German history. Peaceful revolution. At Chemnitz, as in other towns, the pointed German helmet was discarded and soft field caps were donned. German officers and men coming into the lager on this day were held up at the gate. They were disarmed. The epaulettes, in the case of officers, were cut off, and the buttons on their caps were also removed. They were then allowed to pass in. No salutes were given. This took place in full view of the prisoners of war.

A soldiers' council was formed in each district, and these men were the masters of the situation.

We were not interfered with, but machine guns were placed outside the wires and trained on the camp in case of trouble. Field guns were trained on the road leading to the lager.

The thoroughness and organization with which the revolution was carried out was remarkable.

German officers coming into the lager to carry on their duties were not saluted by the German sentries. In one case I distinctly saw a German sentry wait until the officer was within three paces of him, and then deliberately turn about so that his back was toward the officer. As soon as he had passed he turned round to his former position. The iron discipline had snapped.

The mass meeting was held in Chemnitz at which representatives of prisoners of war attended.

November 10. Kaiser abdicated. Armistice terms were received at headquarters. Saxony declared itself a republic. Most of the German officers had retired into civil life by now.

November 11. Everything quiet in camp. We were asked to hang out red handkerchiefs as a sign that we sympathized with the revolution. The interpreter who made the request "got the bird." He followed this up with the request that the men should remove their regimental cap-badges, and then he did get the bird in good style, several of the boys telling him to come and cut them off. This interpreter was one of those who had cut off German officers' epaulettes. Needless to state he didn't take advantage of the offer.

We were informed that addresses in various languages would be made to the prisoners of war, explaining the revolution. Addresses were delivered in Russian and also, I believe, in Italian, but they were stopped. Repeated requests were made that our band should lead a party through Chemnitz, protection being guaranteed. This bait was politely but firmly turned down.

November 13. Discipline greatly relaxed. Had to attend hospital to have my arm lanced, as the result of a spill at football. Being in naval rig, and wearing my arm in a sling, I went by the name of "Nelson." Several facetious members offered to close up one of my eyes in order to make the picture complete.

November 14. A few men taken out in town by sentries.

November 15. From now on passes were issued and men were allowed out in town without a guard for a few hours. It was a curious sensation, after four years of armed escort. The time on the pass was from 4 to 8 p.m. Some of the men didn't come back until the next day, so they threatened to stop all passes.

November 17. All passes stopped, due to absenteeism.

November 19. Passes issued at the rate of 75 per day. Those on the staff who were working all day received permanent passes. There were over 1,000 men in camp now, and a large number of men got out each night, more than half with bogus passes. It was a point of honour to go into the town looking as smart as possible. The attitude of the civilians changed considerably. Most of them were only too glad that the war was over.

We went everywhere; cafés, theatres, kinemas, all kinds were sampled from the best to the worst. The behaviour of the men in the streets was excellent. In some of the more rowdy cafés, things became a little lively, and, on occasions, men were arrested for being in cafés after 10 o'clock, but they were let out the next morning.

The German troops were returning daily to Chemnitz from the west front, and although we were not molested, they objected to prisoners of war "running the town," and walking up and down the streets with members of the fair sex on their arms. Consequently, an order was given out on parade that any Britisher seen walking with a German girl would be arrested. So many of the boys booked seats at the cinemas and met their acquaintances there. Others donned civvies, and so evaded arrest. Beer of a sort was sold, and wine and schnapps. Coffee, as supplied at the most expensive cafés, was made from acorns; there was no real coffee in Chemnitz.

One night a small party of us went to the opera to see Fidelio. Under such conditions one sees the German at his best. The rapt attention, the absence of whispering, and the air of placid enjoyment were most marked. Between the acts we mixed with the crowd and promenaded round the gangways. While we certainly attracted attention, it was by no means hostile. Well-dressed people calmly ate their black-bread sandwiches which they had brought with them while they strolled about.

We had to have special passes for the theatre at first, and the "soldiers' council" officials made themselves rather objectionable by coming into the theatres and demanding to see the passes while the play was proceeding.

After about two weeks, the soldiers who were on duty in the town started to make things warm if any prisoners of war were caught out after 10 p.m. Revolvers were produced on several occasions by the soldier police, but no firing took place.

Things were not going quite so smoothly now as they had at first. German soldiers returning from the west front on some occasions refused to give up their arms, and fights took place between the council men and the returned soldiers. Machine guns were used on several occasions.

Life in the lager was most unwholesome. Discipline had gone by the board. Fires were lighted for drumming-up all over the barracks, and the place became thick with smoke as there was no outlet. No notice was taken of the new guards' orders. The working parties who were responsible for cleaning the lager and latrines struck work, with the result that the place, over-crowded as it was, presented a filthy and unhealthy appearance.

Men were becoming very fed up and parcels were giving out. Many were taking French leave and going out to small kommandos. The men on kommandos struck work, and although threatened with all kinds of punishment, refused to carry on. The soldiers' council then issued an appeal to all prisoners of war to carry on working, as otherwise the whole community would become disorganized. This appeal had no effect, as the men wanted to be sent home.

I was having a bad time with my arm, which was lanced two or three times a week, and abscesses were breaking out on my legs as well. I was dressed daily by a French sanität. The hospital was full up, and sick men were arriving daily.

A great state of restlessness pervaded the whole camp. Nearly a month had passed since the armistice was signed and no sign of a move. We were over 300 miles from the Dutch border, food was getting scarce, and we were not allowed to travel without a pass. So things didn't look too cheerful.

December 5. Three British officers arrived to arrange for our departure.

December 9. First party warned off for Blighty.

December 10. Felt unwell, went to the sanität, had another abscess lanced, and asked him to fix me up so that I could travel, as I was in the first batch. Left the lager 1.25 for Chemnitz railway station. Some of the band wanted to play us to the station, but this was not allowed, and strict orders were given that there should be no singing or demonstrations.

We waited some time for the train; and as it drew in, a group of German officers who had returned from the west front came on to the opposite platform, and scowled at us. So, as soon as we were on board, we all sang "Good-by-ee-e" to them. They did look savage.

It was a most uncomfortable journey of two nights and a day. We had no lights and the only water obtainable came from the engine.

December 12. Boarded Danish Red Cross steamer at Warnemünde. We breakfasted on cooked fresh meat, practically the first fresh meat for several years. There was a choppy sea running and nearly every one was sick. We reached Copenhagen at 3 p.m. During the passage I received medical attention, which I sorely needed. We marched 5 miles to a Danish lager.

December 13. Every man Jack of us was suffering from acute diarrhœa, due to the fresh meat we had eaten. The Danes treated us well and fed us well.

December 14. Parades, and some men were rekitted. I reported sick, and got dressed.

December 15. Left Danish quarters and got on board H.M.S. Plassy at 2 p.m. Pushed off at 4 p.m. We were escorted by a cruiser which sunk two or three mines on the way over. Every one wore a lifebelt day and night.

December 17. Sighted lightship on Scottish coast at 6.30 p.m.

December 18. Landed at Leith, where we had a top-hole reception. Entrained at 4.30 p.m. Arrived at Ripon 11 p.m. We filled out papers and gave in the names of Germans who had been guilty of brutal treatment to prisoners.

December 20. Medical inspection, rekitted, money changed, and each man received rail warrant and money.

December 21. Entrained 11 p.m., reached London 8 p.m., and home at 10 p.m. The excitement kept me going the first night, but on the next I was delirious, and was kept in bed for a week or two as the result of blood poisoning.

In conclusion I should like to record the deep appreciation felt by British prisoners of war toward those responsible for sending out food parcels. It is no exaggeration to state that many of them who are now home would be under German soil but for the parcels. The Russians received no parcels, except in isolated cases, and the number of deaths among them was appalling, due to various causes but primarily to insufficient nourishment. The Germans treated them like dogs.

It is a significant fact that the attitude of the Germans became more brutal to British prisoners of war during those periods when we were short of food, and were consequently weak from hunger.

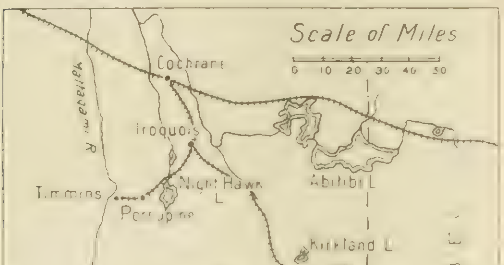
We are now at peace with Germany, but one does not readily forget the murder of Matthews of the R.N.D., Skitt of the Life Guards, and Russell of the Rifle Brigade, or the deaths through starvation of Rootham and Ireland of the R.N.D.; and these are only a few examples of German "kultur."

PRESENT CONDITIONS AT PORCUPINE, ONTARIO.

By FRANK C. LORING.

The importance of Porcupine as a gold producer, and the opportunies it offers for future exploration and development, are not fully appreciated in this country.

THE Porcupine gold area is situated about 450 miles north of Toronto on a branch of the Temiskaming & Northern Ontario railroad. Active mining operations began in 1908. Owing to transport difficulties a comparatively small amount of development work was done until the construction of the railroad



MAP SHOWING POSITION OF PORCUPINE.

in 1910. Since that time the district has increased in importance and extent of gold production, until to-day it is the greatest gold producer in Canada.

The ore-bodies are usually found in shear zones on the sides of porphyry intrusions. These shear zones sometimes have a width of 300 to 400 ft. The course of the long axes of the porphyry dykes and also of the schisted shear zones adjoining is usually about N70°E. These ore-bodies usually consist of lenses of quartz or of basalt, or other of the Keewatin rocks, altered by the deposition of quartz, pyrite, and calcite. Ore sometimes occurs in the porphyry on or near to the contacts of the older Keewatin rock with the porphyry.

In the Hollinger, McIntyre, Dome, Davidson, and other important mines in the district, the mineable area often has a width of 200 or 300 ft. This naturally necessitates extensive operations and mining and milling plants of comparatively large capacity. The daily capacity of the Hollinger mine is 3,500 tons of ore, and those of the Dome and McIntyre, although less, are large. The Davidson Consolidated Gold Mines has, so far, only an excellent prospecting plant, but it is preparing to sink a 1,000 ft. shaft and to erect a mill of 500 tons daily capacity as a first unit.

The developed district has an easterly-westerly extent of about 10 miles and a northerly-southerly extent of about 9 miles. The ore-bearing area is, however, much more extensive. Besides the mines mentioned, there are a number of others in active operation, notably the Porcupine Crown, Dome Lake, Vipond, and Schumacher.

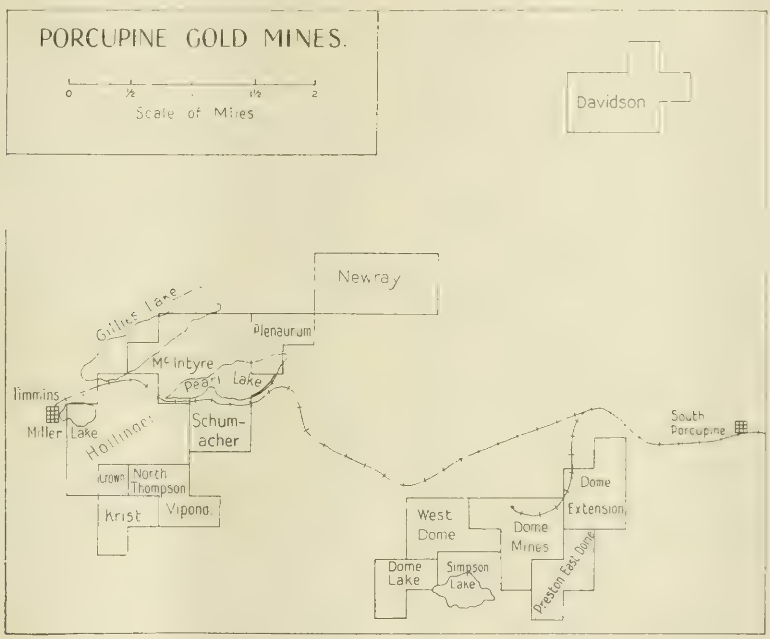
The Hollinger mine is at present the premier mine of the district so far as extent of development and quantity of gold produced is concerned. Other mines in the district with the same stage of development may be rivals of this great property. From the years 1911 to 1918 inclusive, the Hollinger mine, now the Hollinger Consolidated Gold Mines, produced roughly 2,500,000 tons of ore of a gross value recovered of $25,480,000 gold, while $9,424,000 was paid in dividends. The company has been a large investor in Victory Bonds, and possesses a mining and milling plant costing possibly $5,000,000. The grade of the ore as at present mined is between $9 and $10 gold per ton. The total present mining, milling, and other costs are between $4 and $5 per ton, and the total net profit is slightly less than $5 per ton. Were the mine and mill run to full capacity of 3,500 tons daily, the total net annual profits should be above $5,000,000, which would be of 20% on the capital, $25,000,000. Ore reserves, as shown by the company's annual report for 1918, are between four and five million tons of ore of a gross value of about $45,000,000. Practically all of this ore is above the 600 ft. level. The mine has been explored by diamond-drill and otherwise to a vein depth of 1,500 ft., and the same conditions as to geology, the number of veins and grade of ore, exist to that depth. It is evident that these facts show the Hollinger mine to be one of the great gold mines of the world.

Since the foregoing paragraph was written, the Hollinger company has issued its report for the first half of 1919. During this time 316,386 tons of ore yield gold worth $3,166,625 at a cost of $1,519,756, the yield and cost per ton being $9·93 and $4·94 respectively. Dividends absorbing $738,000 were paid, and $781,756 was added to the surplus.

The McIntyre mine, adjoining the Hollinger, is the second mine of the district so far as extent of development and amount of production are concerned. The grade of ore milled is above $10 per ton, and the annual production with present mill capacity is about 2 million dollars gross. Development has been continued to below 1,400 ft., and the ore reserves are upward of 5 million dollars gross. The McIntyre company has acquired considerable adjoining territory with ore-producing potentialities, including the Plenaurum. With increased mill capacity and further development on the extensive territory now owned by this company, gold production should largely increase in the future.

On the same shear zone as the Hollinger and McIntyre and three miles north-easterly, is situated the property of the Davidson Consolidated Gold Mines. This company owns 360 acres of territory and controls additional ground. The mining plant is not sufficiently large for extensive operations, as the present mill capacity of 10 stamps is only from 30 to 40 tons per day. The mine has been developed to a vein depth of 650 ft. The deepest level shows a width of 23 ft. of ore, carrying $19 to $21 gold per ton. With adequate plant and mill, this property should also be a big producer.

The Dome mine is situated about two miles south of the Hollinger ore zone. This mine, as its name indicates, consists of an extensive body or chimney of ore, estimated to contain about two million tons of $5 ore in reserve. The ore-body has been explored to a depth of about 800 ft., and it is reported to maintain its width and length at this depth.



The Porcupine Crown, Vipond, Schumacher, Dome Lake, and some other properties have been explored to 400 to 900 ft. in depth.

There is no evidence in any of the mines mentioned that the limit of the ore-bearing horizon has been reached.

It is evident from the foregoing that the Porcupine district will continue and increase as a gold producer for a long period, and that the amount of gold produced will be of considerable importance.

THE MINERALS OF ANATOLIA

By NORMAN M. PENZER, B.A., F.G.S.

The author gives particulars of the mineral deposits of part of Asiatic Turkey, about which little is known in this country, though the Germans compiled records some years ago.

(Continued from September issue, page 156.)

ANTIMONY.—There is very little geological information about the antimony mines of Anatolia. Antimony occurs in the form of stibnite in irregular veins, usually interstratified with argillaceous schists, metamorphosed schists, micaceous schists, and gneisses. Mercury is closely associated with the antimony, and in this respect resembles the deposits of North Africa. The only two vilayets where antimony is found in any quantity are Brusa and Aidin.

The chief mine in Brusa is that of Gomek-chiftlik-Antimonmaden, situated in the sandjak of Kutaya, 15 miles east of Gedis. The stibnite occurs in an amphibole gneiss passing into a granular limestone. The deposit is most irregular and the veins constantly change in direction and thickness. The annual production about ten years ago was 500 tons.

Two further deposits are situated in the sandjak of Balıkesri. The first lies between the slopes of the Geukje Dagh and the Dagh Ardi, four miles south-west of Bali and 60 miles south of Brusa. The other deposit of this sandjak is 4 miles north-east of Ivrindi, and 29 miles due east of Edremid. Apparently neither has been much worked, and no figures are obtainable.

In the sandjak of Brusa quartz flakes with stibnite embedded in argillaceous schists were formerly found at Demir-Kapou, 5 miles south-west of Sultan-Chair, and 52 miles south-west of Brusa. In the sandjak of Bilejik antimony has been found in small quantities at Seuluklu, on the eastern slope of the Heshich Dagh (Olympus), between Ainegeul and Bilejik.

In the vilayet of Aidin and sandjak of Smyrna (caza of Odemish) is the mine of Chinlikaya (sometimes spelt Djinlikaya). It is situated on the north-western slopes of the Baliamboli Dagh. The mine has been worked energetically during the war, and is said to contain stibnite yielding 65% of antimony. The veins occur in crystalline schists. The annual output, which in 1901 was only 400 tons, is about double that amount, but it is estimated that with the aid of larger capital over 1,000 tons could be produced. About 1902, work was commenced at the antimony mines at Kordelio on the north side of the port of Smyrna. At first only 100 tons per annum were produced, but a considerably increased output has since been obtained. Antimony has been also found on the south-west slope of Kizil Dagh, 16 miles south-west of Smyrna. The workings are shallow open-cut. Practically all shipments are made by way of Smyrna. The total annual production of stibnite in Anatolia is estimated at 2,500 tons.

MERCURY.—Most of the occurrences of cinnabar are in the vilayet of Aidin, although there is one in Konia and another in Brusa.

In the north east of the Kara Burun peninsula, sandjak of Smyrna, at Akhirli, Sahib, and Tepejik at the foot of the Boz Dagh (not to be confused with the Boz Dagh near Eskishehr), are several cinnabar deposits. They have been described by D'Achiardi, who says that a highly metamorphic dark schist is traversed in a north and south direction by a quartzose brecciated rock, 26 ft. in thickness, carrying 2 to 2½% mercury. The west wall of the schist contains 0·3% mercury, while the east wall is a breccia flanked by 10 ft. of yellow and red ochreous deposits, which, although poor in cinnabar, are rich in nodules of pyrites. The schist has been proved 300 ft. to the east, and abuts against a Cretaceous limestone. To the west it is interrupted by basalts. Cinnabar-bearing quartz cross-veins occur in the schist near the limestone. The deposits are worked by the Kara Burun Mercury Syndicate, Ltd. The yearly production is about 3,000 flasks (a flask = 76½ lb.). Mining is all done in open-cuts, and the ores worked contain sometimes as little as 0·25% Hg. The cinnabar appears to be in the fines, and the ore is concentrated by screening. The plant at the mines consists of two double Spirek furnaces for broken ore and a Cermak-Spirek furnace for fine. The capacity of this installation is thirty tons per day.

Other occurrences of cinnabar in the sandjak of Smyrna are near Odemish, and about 10 miles south-west of Tire. That near Odemish is just outside the village of Halikeui, at the foot of Baliamboli, not far from the antimony mine of Chinlikaya, already described. The mercury is only found in traces which occur in veins of pyrites in the mica-schists. They have been very little worked, if at all.

The mines south-west of Tire are situated at Ebibler, Karakilisse, and Chamkeui. They were worked very little before the war. The precentage of mercury obtained varies from one to twenty. Numerous ancient levels have been found in the Chamkeui mine, and are supposed to be those referred to by Pliny. The cinnabar occurs in argillaceous schists, and is associated with iron oxide.

In the vilayet and sandjak of Konia, at Sisma, near the town of Konia, cinnabar occurs in veinlets, nodules, and small particles in a crystalline limestone in close proximity with schists. The mineral is present wherever the limestone has become silicified. Stibnite has been found associated with the cinnabar. The output was good in 1913, but no figures are to hand.

A deposit of cinnabar has lately been discovered near Oshak, sandjak of Kutaya, vilayet of Brusa.

It was reported in the foreign press that during the war the Deutsche-Turkische Montangesellschaft of Munich either rented or bought all the mercury mines of Anatolia that were in working order or could be easily started again. Arrangements were also made for the Kriegemetall-Aktiengesellschaft to purchase as much of the output as possible.

The total production of mercury per year in Anatolia is estimated at between 4,000 and 5,000 flasks.

EMERY (CORUNDUM).—Practically the entire output of the emery of the world used to come from the island of Naxos, one of the Cyclades in the Archipelago. The Naxos emery has been exploited from very early times and was known by the name of Naxium to Pliny and other Roman writers. It has been fully described by Professor G. Tschermak and is not included in our survey. For long the island of Naxos was the only producer of emery in this part of the world, but in 1849 Dr. Lawrence Smith, when investigating Turkish mineral resources, discovered deposits on the mainland south of Smyrna, which he described in a paper published the next year. The deposits were further developed by Jackson, Charnand, Abbott, and others, and were described fairly fully in 1898 by Thomae, while among the most recent accounts may be mentioned that of De Launay.

The most important deposits are situated (1) on the Gumush Dagh, immediately north of Sokia, 48 miles SSE of Symrna, and (2) seven miles NE of Tire. The chief localities are Alaman, which lies to the south of Alaman Dagh, just north of the Gumush Dagh; Alajali; Kozbunar; Hassan-Chaulsar; Yenikeui; Kurshak. Many of the deposits are now exhausted, while others have hardly been worked at all.

Two different kinds of deposits are distinguished: (1) the mineral in situ, known as rock-emery; (2) emery detritus, due to weathering. The rock-emery is found in irregular pockets in the limestone. Their width varies from a few feet up to two hundred, their length to three hundred, and their depth from ten to fifty feet. It is possible to sink far deeper shafts, but owing to the output from surface deposits being sufficient, coupled with the extra expense, deeply-worked mines hardly exist at all.

The walls of the deposits are most irregular. Thomae describes the limestone as intruding and receding most unexpectedly; the demarcation between it and the deposit is beyond the range of decomposition; all is distinct with no gradual merging of the one into the other, though the limestone, being in juxtaposition, is often stained and veined with brown seams.

The detrital deposits are chiefly found on the surface, and therefore are far more easy to work, although they are not nearly so extensive as the rock-emery already described. They consist of fragments of various sizes, which are embedded in a compact clay, usually coloured red by iron oxide. They also occur in close association with deposits of rock-emery and are obviously due to weathering. In other cases the rock-emery has weathered entirely away and only the detrital deposit is left.

The ore is mixed with various silicate minerals, including margarite, biotite, chlorite, and chloritoid. The quality of the emery is dependent upon the quantity of these minerals that is present in the ore. They sometimes, however, occur in distinct veins. Emery is found in a reddish soil and is sometimes associated with mica-schist, gneiss, and granite. The proportion of the corundum varies from 37 to 57%.

Owing to the perfect cleavage and cross-cleavage, the ore can often be mined without the use of explosives. The emery caves somewhat resemble the stalactite caves of England, as the entrances are small, opening into big caves, the roofs of which are supported by natural pillars. The emery is broken up and carefully picked over by hand, and taken on camels, carrying about 4 to 5 cwt. each, to the nearest port or station. It has then to be ground or stamped and separated into grades by screens. The higher grades are prepared mainly by elutriation, the finest quality being known as "flower of emery." The fine powder which is collected in the stamping room is used by lapidaries and plate-glass manufacturers.

The following are some of the most recent concessions granted for the working of emery mines in the vilayet of Aidin:

(1) A Turkish financial group has obtained a concession for the working of deposits at Torbali for 60 years.

(2) Concession granted for 60 years for emery mine containing iron, situated in the village of Haissardjik in the caza of Milas.

(3) A similar deposit in the village of Sou-dere, also in the caza of Milas.

(4) A similar deposit in the village of Karaoglou, in the caza of Milas.

As regards the output, of late years America has put on the market artificial products for grinding and polishing purposes, which have been somewhat detrimental to emery. In spite of this fact the export figures at Smyrna are large. The following table compares them with those of the other two chief emery exporters of the world:

Years	Turkey Tons	Greece Tons	U.S.A Tons
1905	13,182	6,97[illegible]	1,929
1906	17,565	7,565	[illegible]
1907	[illegible]	10,589	970
1908	20,304	7,471	607
1909	18,215	8,193	[illegible]

According to other statistics, the world's consumption of emery is given at 25,000 tons per annum, of which Asia Minor supplies some 18,000 tons, valued at £53,000, Canada 388 tons, valued at £10,914, and Naxos 6,328 tons, valued at £26,830.

The only other vilayet in Anatolia in which emery occurs is Adana, where a deposit has recently been recorded at Alaya.

IRON.—A large amount of iron exists in Anatolia in different localities, but is usually found in association with other minerals such as emery, copper, etc. It has hardly been worked at all owing, in the first place, to lack of fuel, and, secondly, to lack of transport. The most important mines are in the vilayet of Aidin, at Beche-Parmak; the deposits here show a mixture of hematite and magnetite in micaceous schists. The only other occurrence in Aidin is that at Kurubel near Denizli. At Eski-shehr, in the village of Brusa, iron ore is found containing 70% of iron compounds and 30% of manganese compounds. The only other iron mines of any importance in this vilayet are those at the villages of Altoun Tache and Bourgas, situated in the caza of Mudania. The right to work these has been granted to an Ottoman subject for 99 years, dating from 2 or 3 years back. In the village of Adana there are iron mines on the south-east side of the Bel Dagh, at Baghchejik, 21 miles NNE of Adana. The emery and iron mine at Alaya has already been referred to.

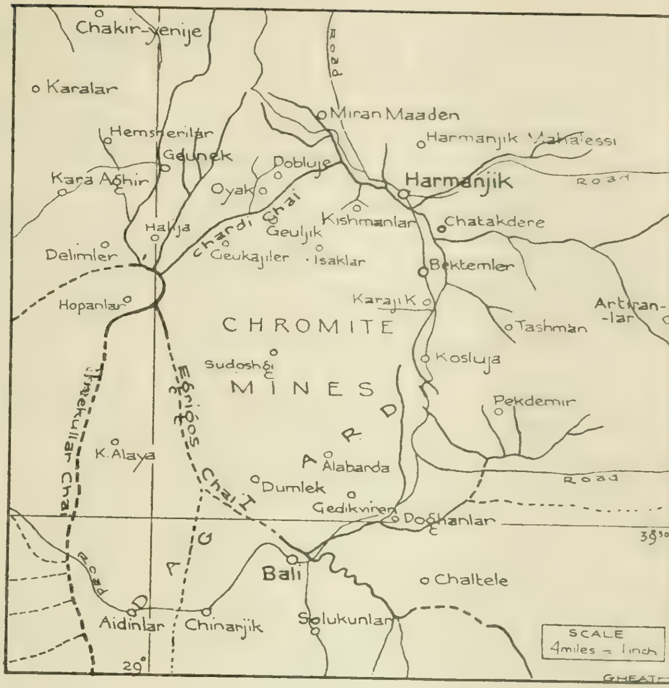
MANGANESE.—The occurrences of manganese are few and unimportant. They are for the most part associated with other minerals such as iron and emery. In the sandjak of Ismid there is a mine about seven miles from Ak Hissar, but no details as to output are obtainable. In the vilayet of Brusa a little manganese is found near the silver-lead mines of Balia-Maden. It occurs where the augitic andesite joins the limestone, and is in the form of pyrolusite, which is partly mixed with the decomposed limestone. This weathering has caused cavities in the joints of the limestone, which at places reach considerable size. There are also deposits near Hereclea. In the sandjak of Bigha there are five occurrences of manganese in association with other minerals, but they are so slight as to hardly warrant mention. Traces of manganese occur in Konia and Trebizonde. There are also some mines which have lately been worked in the vilayet of Trebizonde, but they come outside our area. Small beds occur at Ayasmand, north of Smyrna.

Since the war a number of concessions have been granted in the vilayet of Aidin to Turks and Germans, among which are the following: (1) To a Turk for 99 years, village of Kutchuk, caza of Fethie. (2) To a Turk at Kapali Kapouz Dere, caza of Kendjeghuz. (3) To a German, village of Inlondja, caza of Fethie.

The annual production averages in normal times 12,000 tons.

CHROMIUM.—The chief chromite mines are found in the vilayets of Brusa and Aidin. The chromite district in Brusa covers an area stretching about 15 miles east and west and 8 miles north and south. It is situated in the nahiye of Dagh Ardi and caza of Simav. The chief town in the neighbourhood is Harmanjik (Chardi) which is 52 miles ESE of Sultan-Chair on the Soma-Panderma Railway. The chromite is soft and quite easily worked. The output of the Dagh Ardi mines alone averages from between 12,000 and 15,000 tons per year. The mineral is taken to the port of Derinje on the Gulf of Ismid. The total cost of mining and transporting a ton of ore to Derinje including all expenses is about £2. A mine known by the name of Mirankoi yields 3,000 tons and that of Kosluja 1,250 tons per year. There are also mines near Artiranlar and Alabarda. The entire district yields about 16,000 tons. The United Kingdom imports nearly two-thirds of these ores, and the remainder is divided between Germany and the United States.

The Aidin mines are situated in the extreme southern corner of the vilayet near Makri, opposite the Island of Rhodes. The chromic acid contents vary from a trace to as much as 58%. If the percentage is much under 47% it is not considered good enough for export. Some years before the war a 50% ore would fetch £3. 12s. per ton f.o.b. on the coast, 52% £3. 14s., and so on, in proportion. The richest ores appear to be those nearest the surface. The output is only quite small, though at one time it was very considerable. Other occurrences in Aidin are near Denizli. The ore is in irregular pockets and veins in the serpentine, but the output is only small. These mines have been profitably worked during the war.



MAP OF THE BRUSA CHROMITE DISTRICT.

Apart from the vilayets of Brusa and Aidin, chromite is mined near the Gulf of Adalia, in the vilayet of Konia. The ores yielded as much as 55·5% of the oxide, but owing to the drop in prices most of the mines closed down. In the vilayet of Adana three mines were worked near Mersina, quite close to the coast. The methods of working were most primitive, but about 2,000 tons per year was produced. The only other deposits worth mentioning are in Bigha.

The low prices which ruled for chrome ores for some years previous to the war have been the chief cause for the reduction in the Turkish output. However, during the war the attention of the Germans was drawn to the mines of Aidin and were properly surveyed. Krupps acquired the concessions of two or three mines. A report from the foreign press in 1917 dealing with deliveries indicates that the output during the war was considerable. As soon as communications are improved the production of chromite should be important. Sixty concessions have already been granted for working the chromite mines in Anatolia. The present annual output may be estimated at about 18,000 tons.

COPPER.—By far the most important copper mines in Anatolia are those of Arghana Maden in the vilayet of Diarbekir, but they fall just outside the area under consideration, and so will not be described. There are copper mines in most of the other vilayets, but they are all small and often unworked.

In the vilayet of Sivas, copper occurs just outside the capital, at Yildiz, Zara, and Tokat. Copper is imported at Tokat from Arghana Maden, and it receives there its final refining before going on to Samsoun. Although several concessions have been granted in Sivas no workings were commenced up to the outbreak of war. There might be a big future for copper mining in Sivas, but owing to the enormous difficulties of transport and the bad state of the so-called roads in winter, prospects do not look very bright. There are about a dozen localities in Trebizonde where copper is found in small quantities, but they all fall just east of our boundary line. In the vilayet of Adana, copper is found near Selefke, 10 miles from the coast. In Castamuni, about 60 miles due north of the capital and 15 miles from Ineboli, on the Black Sea, are the old copper mines of Kureh, but the present output is hardly worth mentioning. Copper has also been reported from Aidin, Brusa, and Ismid, but the occurrences are only small and in association with other minerals.

No figures are obtainable showing the output of the Anatolian mines, other than Arghana Maden, but the total would probably not be more than 100 tons per year.

(To be continued).

LETTERS TO THE EDITOR

Spitsbergen.

The Editor:

Sir—I was really astonished to see the lengthy article of Mr. Mansfield in the August issue of the Magazine. In fact, the Northern Exploration Company could have found no worse defendant for their bad cause than the said gentleman. Instead of a refutation based on the facts of my charges against the Northern Exploration Company of imposing upon the English Government and public, Mr. Mansfield hides behind a smoke-screen of cheap arguments, characteristic of the adventurous prospector, and behind talks of politics and indecent insinuations. I will, however, treat him seriously and give a large amount of additional information, some of which he has called for.

Three iron experts examined the Recherche Bay iron deposits. One of these was Mr. H. Morch-Olsen, of Kristiania, a mining engineer graduated from the University of Kristiania, with experience in Norwegian and Minnesota iron mines. He examined the deposit in Recherche Bay in 1912 for the Stavanger-Spitsbergenske Kulkompani. As a result of his report, the deposit was dropped. Two other engineers examined the property for Swedish and Dutch parties respectively, with the same result. [Mr. Marstrander is not at liberty to mention these names publicly, but he has given the particulars to us privately, and we can assure readers that the names are quite good and above suspicion.—EDITOR]. I can also inform you that I received news, some days ago, from my friend Mr. Adolf Hoel, State Geologist, now at Spitsbergen, that he had visited the deposit and found it even more insignificant than he had imagined.

Mr. Mansfield tells us that he protested against the trespasses of the Swedes in 1911, and warned them against the possible consequences thereof. The Swedish company has a share capital of several million crowns, and gave to the Northern Exploration Company free shares to the amount of 50,000 crowns, in order to get rid of them. It is the buildings, piers, and works of the Swedish company in Braganza Bay that the Northern Exploration Co. reproduces and represents as its own works, in its propaganda pamphlet "Spitsbergen: The Gate to the Northern Markets of Europe."

On pages 14–15 of this pamphlet, the company reproduces a two-page picture of what is called "Coal Strata, Spitsbergen." The picture is taken from Braganza Bay, and the strata seen represent barren slates, so characteristic of the sedimentary table-lands of Spitsbergen. In the pamphlet, the Northern Exploration Co. also tells its shareholders that several hundred thousands of tons of coal have been shipped from Spitsbergen, leading readers to believe that this has been shipped by them. It is a fact, however, that since 1905, the year when the Northern Exploration Co. started its activities in Spitsbergen, the company has not shipped a single ship-load, either of coal or other minerals, except insignificant amounts.

Mr. Mansfield, in his article, says that the main work done by Norwegians in Spitsbergen from 1905 to 1910, was whaling. I wish to inform you, very briefly, of the actual work done in Spitsbergen from 1905 to 1919 by Norwegians.

In 1906–7 there was Captain Isachsen's and the Prince of Monaco's expedition, consisting of three topographers, one geologist, one botanist, and three assistants. They made a survey and study of the geological formations of north-western Spitsbergen. The area mapped covered 1,500 square miles, and they prepared a map with a scale of 1 : 100,000, with contour lines at 50 metres.

In 1908 Hoel's expedition comprised two geologists and one botanist.

In 1909–10 Isachsen's party went out, consisting of 4 topographers, 4 geologists, 2 hydrographers, 8 assistants, etc., total 37 men. The area mapped was about 2,000 sq. miles with a scale of 1 : 100,000.

Staxrud & Hoel's expeditions were in 1911–16. There were 3 topographers, 1 hydrographer, 3 geologists, 3 mining engineers, and 5 assistants, the number varying from one year to the other. During these expeditions, most of the stratigraphy of the coalfields of Western Spitsbergen was thoroughly studied, from a scientific and economic viewpoint, and a most important foundation was laid for future economic and scientific work in the coalfields of Spitsbergen. Maps as large as 1 : 50,000, covering the land between Icefjord and Bell Sound eastward to Advent Valley, 750 sq. miles, were made, on account of the great economic importance of this district.

Hoel's and Rovig's expedition in 1917–18 consisted of from 1 to 4 topographers, 1 hydrographer, 2 geologists, 1 mining engineer, and 8 assistants, in addition to the crew. They explored and mapped the neighbourhoods of Horn Sound and the regions northward; the total area mapped was 1,000 square miles.

In 1919 Hoel's expedition continued the

work from 1918, mapping and exploring the regions from Horn Sound to South Cape. The work is to be finished 1922.

The results of these expeditions are that the entire western part of Spitsbergen, from Wijde Bay, on the north coast, to South Cape, and up to 56 miles inland, covering about 7,000 square miles (about one-fourth of the entire area of Spitsbergen) has been mapped, on scales of from 1 : 50,000 to 1 : 200,000, with contour lines at 50 metres. These maps are founded upon exact base measurements, astronomical observations, and triangulations, a net of triangles extending from the north coast to South Cape, over a distance of 212 miles. As to the exactness of the survey, it may be stated that a side of a triangle calculated from a base at Cales Bay (Icefjord) to be 15,295·7 metres long, was found to be 15,293·5 metres, by starting the calculation from a base measured on the southern shore of Horn Sound. The difference is only 2·2 metres, while the distance between the bases is 130 kilometres, or 81 miles. These maps are without a parallel from any arctic or antarctic land. The following harbours have been sounded and surveyed: Vulkan Harbour, Hamburger Bay, Cross Bay, Signe Harbour, Ebeltoft Harbour, King's Bay, Foreland Sound, Farm Harbour, Ferrier Harbour, Hecla Harbour, Green Harbour, Advent Bay, parts of Icefjord, the entire coast from north of Icefjord to Bell Sound and Horn Sound, and finally the Norwegian harbour of Bear Island. Some 7,000 photos have been taken, most of which are levelled and orientated from fixed trigonometrical points. The geological data are being gathered to form a continuous geological map from north to south, and in 1922, it is calculated, a Norwegian topographical and geological atlas of the entire western part of Spitsbergen will be in existence. [Mr. Marstrander has sent us copies of a number of these maps; they reflect great credit on the producers.—EDITOR].

Beside these more important expeditions, there have been, since 1905, forty other Norwegian expeditions to Spitsbergen, having for their object the examination of the mineral wealth of the islands. If you should want to know the names, places to where they went, and the kind of deposits examined, I am prepared to give you such information.

It is on the basis of the results of all these Norwegian expeditions that I said that, excepting coal, Spitsbergen is poorly supplied with mineral wealth, and that no one knows the islands better than Norwegians do. We do not claim vast territories, proclaiming to our shareholders their enormous contents of riches in almost every ore existing, neither do we waste our money in mining coaly slate for coal, rubble for building material, and quartzite for iron ore.

Mr. Mansfield says that the Norwegian wireless station was built by Germans. No more was it built by Germans than our Transatlantic station at Stavanger was built by Englishmen. For the one, we bought the machinery in Germany, in 1911; for the other, we bought it in England, in 1913. Both stations, however, were built exclusively by Norwegian engineers, as a help to the Norwegian sealers and whalers up there, and to the ever increasing Norwegian settlements at the mines. The great economic interests involved in these industries, and in the consideration of the ice-conditions with respect to shipping, made it imperative to connect Spitsbergen with the rest of the world.

With regard to what Mr. Mansfield calls the "fine sounding outfit," who examined the so-called guano deposits around Horn Sound, I can give him information as to the members of the expeditions. In 1917, the geologists were Adolf Hoel and W. Werenskiold, both State Geologists and teachers in the University of Christiania, and A. K. Orvin was the mining engineer. In 1918, the geologists were again Messrs. Hoel and Werenskiold; J. Braadstad was mining engineer; and A. Koller, W. Solheim, and H. Holst were the topographers. In both years these parties had Horn Sound as their headquarters.

As to my own visits to Spitsbergen, these took place in 1909 and 1911. On the first occasion, I was a member of the geological staff of the Isachsen expedition. On the second, I was sent out by a syndicate in Kristiania to examine coal and mineral deposits. As to the insinuation of my having any connection with German interests in Spitsbergen, this argument, under the present circumstances, s gnifies an accusation which I challenge Mr. Mansfield, or any others, to prove.

ROLF MARSTRANDER.

Kulhuset, Telemarken,
Norway, September 12.

[Mr. Marstrander's first communication on the subject of Spitsbergen appeared in the June issue, and Mr. Mansfield's reply was published in the August issue. Further information relating to Spitsbergen enterprises is given in this issue under the heading Editorial and Review of Mining.—EDITOR].

NEWS LETTERS

MELBOURNE.

July 18.

Wolfram in Queensland.—Details are now available of the work done by Thermo Electric Ltd. in North Queensland in the development of wolfram deposits. The properties were sold recently to the Burma Queensland Corporation. This information is given by Mr. F. C. Cann, the manager. The township of Wolfram lies about 86 miles west of Cairns, the seaport for the mining and agricultural districts of the Cairns hinterland, and 15 miles north-west of Dimbulah, a railway station on the Chillagoe railway, and approximately 1,000 ft. above sea level. The district, for the most part, is composed of granite and quartz-felspar porphyry rocks, consisting of undulating to rough country, broken by a series of hills extending in an east and west direction. The areas of deep soil are fairly thickly timbered with ironbark, bloodwood, and gum, which are used for firewood and general mining purposes; while on the sides of some high granite ranges cypress pine grows sparsely. The flats are principally grass country, but on the hills the general vegetation consists of stunted scrub. Bulluburrah Creek is the main water channel. It heads about 4 miles north of the town and joins the Walsh river 9 miles south-west of the town. The means of access from Dimbulah to Wolfram is by bush roads. The transport of materials is done by teamsters, and the conveyance of passengers and mails by coaches.

The mining district is situated both east and west of the town, and is over 14 miles in length and 1½ miles in breadth. The first mineral discoveries were made about 1897, but owing to the isolation of the district very little work was done until 1905, when the district began to attract attention. A large number of miners then commenced to work the rich alluvial wolfram in the creek beds, and also the lode outcrops and the surface accumulations on the slopes of the hills derived from the lode outcrops. From the latter it was not uncommon to find lumps of wolfram weighing 5 cwt., and some lumps have been found weighing over one ton, while some pieces of metallic bismuth have been found weighing up to 80 lb. The principal minerals mined at present are wolfram, bismuth, and molybdenite, and the district may be considered the premier producer in Australia of those minerals. There are also deposits of tin, silver-lead, and copper, which have been worked by trenches and shallow shafts, but are now abandoned owing to the high cost of transporting the minerals by pack teams to suitable treatment works.

The country rock in which the present discoveries have been made is a portion of the great granite massif which stretches from Wolfram south-west to Bamford and is more or less continuous to the west with the granites of the Koorboora district. The slates and schistose conglomerates strike N 65° W and dip north-easterly at angles of 40° to 85°. The beds alternate rapidly from slate to conglomerate and are intensely folded and strongly metamorphosed and interbedded with bands of shattered porphyritic igneous rock. The granite in its least altered variety is a pink granitite; the felspars are mostly orthoclase with intergrowths of albite. The mica is dirty-green and light brown, and occasionally has a little fluorite associated with it.

The seat of deposition of the wolfram, bismuth, and molybdenite is chiefly near the contact zone. Here the granite has marked marginal development of greisenization, and it is traversed by veins and bands of pegmatite, with intersections of intrusive quartz-felspar porphyry.

The great majority of the important deposits of wolfram, bismuth, and molybdenite being worked consist of pipes of many shapes, but typically they have the appearance of cylindrical masses, very irregular and tortuous, with no general direction in their underlie, though, in many cases, their dip is toward the contact of slate and granite. The three metals are usually companions in the same lode, with the richer patches of bismuth on the foot side. The lodes have no walls, but represent the filling of cavities with massive crystalline quartz, merging into a tough and granular quartzite toward the altered granite periphery.

The mining properties are granted under lease from the Queensland State Government, subject to the mining regulations prevailing in the State. The chief condition, in addition to the rental of ten shillings per acre per annum, is the labour convenant, which provides that at least one man shall be continuously employed for every ten acres under lease, provided that a smaller lease shall be manned by one man. Due provision is made for obtaining total or partial exemption as circumstances arise.

There are about thirty mines, of which twenty are owned by the Burma Queensland Corporation, Limited (formerly the Thermo Electric Ore Reduction Corporation, Limited). The principal work of the corporation during the past two years has been mine development and equipment, installation of electric power plant, and the construction of tramway haulages, aerial ropeway, and reduction plant.

In the past the mining was chiefly open-cut and the ore was hauled to surface by windlass. The method of treatment consisted of hand-picking and dollying the ore, followed by hand-jigging the pulp ; consequently only the rich ore was mined, and only to a depth of about 150 ft.

Regarding the central group of mines owned by the corporation, namely, Leisner, Murphy & Geaney, Larkin, Hillside, Forget-me-not, Hughes, Tully, and Mulligan, these have all been developed by drives and rises, while shafts have been sunk to a depth of 500 ft. in ore. The majority of the ore-bodies are very large, ranging from 20 to 60 ft. diameter. The evidence shows good prospects of extension in depth, as the metal values persist unaltered to the bottom, and the ore-bodies maintain their size.

TORONTO.

September 13.

COBALT.—The miners' strike, which began on July 23, affecting about 2,300 men, was settled on September 8, the men agreeing to accept the terms offered by the employers. The latter remained firm in their determination to refuse recognition of the Union, but admitted the principle of collective bargaining with committees to be appointed by their employees, independent of the Union. They also agreed to increase the base wage by 50 cents per day, the bonus based on the price of silver to be fixed on the excess over 80c. per oz., instead of 60c. as formerly. This ensures greater stability in wages in case of a considerable decrease in the price of the metal. Operations are being rapidly resumed by the leading mines, most of which are in good shape, though in some cases the lower levels are flooded. The Coniagas and Trethewey are operating at full capacity, and the Kerr Lake, Crown Reserve, McKinley-Darragh, and Adanac are working on the upper levels. There is some difficulty in securing labour, owing to so many of the strikers having left the district, but most of them are returning, and it is expected that normal conditions will be restored by the end of the month. The high price of silver is stimulating production, and owners of many old properties which have been closed for years are planning to resume operations.

PORCUPINE.—Porcupine has benefited to some extent by the strikes elsewhere, which have caused an influx of labour, but there is still a demand for more men. The Hollinger Consolidated has issued a report covering the period from January 1 to June 26, showing a total income of $3,166,626, and operating costs amounting to $1,646,868, leaving net profits of $1,519,756, of which $738,000 was paid in dividends and $781,756 added to the surplus. The mill treated 316,386 tons of ore of the average value of $9·93 per ton, and the costs per ton were $4·94. There were 1,311 men on the pay-roll, and an effort is being made to increase the force by 500 men. If these could be obtained the company is in a position to largely increase its output. The Dome Mines during August treated 25,000 tons of ore, the mill-heads showing about $9·80 per ton. Profits are estimated at about 50%. The directorate considers it inadvisable at present to issue official monthly statements in view of the uncertainty of conditions and the fact that the mill has latterly been treating ore of much higher grade than the average of the reserves, which is estimated at $5·10 per ton, so that a favourable statement for a brief period might be misleading. It is understood that the mill-heads will be gradually reduced as the milling capacity is increased. The Dome is actively pushing development on the adjacent Dome Extension, on which it holds an option. It is completing its fourth cross-cut into the Dome Extension ore-body on the 600 ft. level. The cross-cuts are 75 ft. apart, and in the one thought to be at the widest part of the deposit 99 ft. was cut. Stoping is under way. The nature of the work undertaken leads to the general belief that the Dome management intends to exercise the option. At the McIntyre 800 ft. of No. 5 vein opened up on the 1,100 ft. level shows higher gold content than on the upper levels. Values are reported to run $11 to the ton over a width of 30 ft. A change in the formation occurs at this depth, quartz being displaced by sulphides, necessitating finer grinding, and a tube-mill is being installed. About 40 tons of ore per day is being taken from the upper levels of the Plenaurum, but a heavy flow of water has been encountered at the 1,000 ft. level of this property, rendering deep mining difficult. The shareholders of the Dome Lake have ratified a by-law providing for the issue of bonds for $100,000 to raise funds for development. L. G. Harris, general manager of North Davidson, has gone to London to interest British financiers in the property, the company's plans requiring an outlay of $200,000. The Keora is planning the sinking of a shaft to open up a body of high-grade ore discovered by diamond-drilling. The Porcupine Crown, which was closed for some time, has been unwatered and work resumed. At the Clifton Porcupine a substantial tonnage of ore has been placed in sight on the first level of the Boulder vein. An electrical equipment is in process of installation.

KIRKLAND LAKE.—The expectation that the strike of miners at Kirkland Lake would terminate simultaneously with the Cobalt strike was not realized. The miners at last accounts were still out, though negotiations for a settlement were on foot, and it is expected that an understanding will very shortly be reached. In the meantime work has been at a standstill except at a few new mines and prospects on the outskirts of the camp. Exploration work is in progress at the Granby-Kirkland, about a mile north-east from the Tough Oakes, where trenching has disclosed three promising veins, varying in width from 3 to 5 ft. The Lake Shore is planning the installation of additional mill equipment. The Kirkland Porphyry, which has only a few shareholders and no creditors, has gone into voluntary liquidation.

LARDER LAKE.—The Larder Lake camp, which for several years has attracted little attention, is again coming into prominence. Shortly after the first discoveries it was unscrupulously boomed by wild-cat promoters causing widespread losses to investors, following which many thousand claims staked in the early days were allowed to lapse. Operations, however, have been steadily carried on by the Associated Goldfields, who are working several properties on an extensive scale, opening up large bodies of low-grade ore. In cross-cutting recently on the Dr. Reddick property at the 100 ft. level a strike was made of a low-grade deposit which proved to be a continuation of a 300 ft. wide ore-body on the Kerr-Addison property adjoining, which lengthens it to a total of about 2,000 ft. Many prospectors have come into the area this season re-staking the abandoned claims, and it is estimated that there are now about 500 men at work in addition to the large force employed by the Associated Goldfields. The Crown Reserve of Cobalt has bought two claims at a price stated to be high.

BOSTON CREEK.—The area of the Boston Creek goldfield is being broadened out by numerous additional finds, and work is being carried on at many points outside its original limits. The Miller Independence is installing a new mining and milling plant and has contracted for electric power. Diamond-drilling is being actively carried on at the Allied Gold Mines properties, and a vein has been cut which is believed to be a continuation of the Miller Independence vein. The Peerless is putting down a shaft 200 ft. At the Campbell-Duncan claim some remarkably rich ore has been taken out of a test pit.

CAMBORNE.

DOLCOATH.—The report for the six months ended June 30, 1919, makes the reverse of cheerful reading; a loss of £19,510 for that period is enough to damp the spirits of even the most optimistic shareholder. As will be seen from the appended figures, the quantity of ore raised shows a slight increase, but the recovery is down by 1·4 lb. per ton, while the average price realized for the tin concentrate shows a fall of over £70 per ton. On the other hand, the operating cost shows a reduction of 1s. per ton milled, while the loss per ton milled figures at no less than 13s. 6d.

	Six months ended		
	June 30, 1918	Dec. 31, 1918	June 30, 1919
Tons ore milled	32,783	28,716	26,877
Black tin sold, tons	424	403	387
Recovery per ton milled, lb.	28·97	31·45	30·05
Average price per ton of black tin	£189	£189	£118
Black tin sales, value	£79,917	£76,104	£45,876
Total receipts } per ton of	50s. 11d.	57s. 10d	33s. 3d
Working cost } ore milled	41s. 11d.*	47s. 9d.	46s. 9d.
Profit, per ton	9s.	10s. 1d.	—
Loss, per ton	—	—	13s. 6d

* Includes 1s. 9d. for royalties; company now owns the freehold.

The development footage is again deplorably small, the total for the six months being only 460 ft., and while it is true that there have been difficulties to surmount, one cannot refrain from remarking that enterprise in this direction has been sadly lacking. The early promise of the exploratory work at the 352 fm. level, west of Stray Park shaft, has not been maintained. For six fathoms the lode averaged 60 lb. per ton, but it then reached disordered ground and became split up, and this too was found to be the state of affairs in the cross-cut put out to intersect the lode at the lower level of 375 fm. A rise is now being put up from the 352 to communicate with the 338 fm. level, as soon as this latter is extended sufficiently; this rise will both test the lode and facilitate stoping if the values so warrant. Other promising exploratory work is being carried out in this western section of the mine, and with regard to this, Mr. R. Arthur Thomas said at the shareholders' meeting that "the prospects for the discovery of a profitable lode in this district of the mine seem to be assured." The language is somewhat ambiguous, but presumably it was intended to indicate his confidence in the result of these western explorations. Outside of this section, and excluding development of the main lode in depth, there are no other points of attack likely to open up any considerable tonnage of payable ore. No headway appears to have been made with the plans for exploring the Roskear setts to the north; presumably the scheme will be submitted in due course to the Non-Ferrous Mining Committee of Inquiry with a view to securing Government financial support.

LEVANT.—As briefly referred to in the last issue, the report for the four months ended August 23 last showed a loss of £2,976, and a call was made on the shareholders of £1 per share, producing £2,500. In addition, £2,300 was spent on work of a capital nature, and presumably this will be taken into account if and when a new company is formed to acquire the property and plant. It may, at any rate, be regarded as an indication of the confidence of those controlling the undertaking that fresh capital will be forthcoming in the near future, and we understand the mine is now being examined and reported on for this purpose. It is proposed to sink a new vertical shaft, and already a winding engine—previously located at Basset—has been purchased. The tin recovery for the period under review was 46 lb. per ton of ore milled, and if Captain Nicholas can increase his tonnage for the present quarter, as he anticipates, by 2,000 without seriously lowering the grade, and the price of tin does not go back, then the mine ought to be operated without loss. The operating cost for the past quarter was approximately 77s. per ton, and with tin metal at £270 as at present, ore of the grade mentioned is worth about the same figure. This high operating cost—practically 100% higher than at some of the Camborne mines—is the bugbear of Levant, and there can be little doubt, that, given modern plant, this can be materially reduced. It would be interesting to know the assay of the tailings from the dressing plant; we venture to think the recoverable loss in this direction is considerable.

RAINFALL AND PUMPING COSTS.—A useful paper was recently read by Mr. A. Pearse Jenkin, before the Royal Cornwall Polytechnic Society on "The Relation between Rainfall and Cornish Mine Pumping." One of the outstanding facts disclosed was that variations in the summer rainfall had little or no effect on the water to be pumped. The author appears to have come to the conclusion from the data at his disposal that apart from special conditions, such as cross-courses, the country from the surface to a considerable depth acted as a kind of sponge, which was drained by the shafts. During the summer, these strata were being drained below the saturation point, and while the "country" was in that condition, no increase of rainfall affected the pumping, but as winter approached, the increased rainfall brought the "country" up to saturation point, after which the effect of the rainfall became quickly apparent. The condition might, indeed, be compared to a funnel fitted with a spongy material (the "country") with a hole in the bottom (the shaft). While the sponge was unsaturated, the attraction of the material prevented much water finding its way down the hole at the bottom, and moderate amounts of water poured in merely damped the sponge, but when once the sponge was saturated, the water found its way to the hole at the bottom.

NORTH OF ENGLAND.

THE GOVERNMENT COMMISSION.—Dr. F. H. Hatch, the new Controller, accompanied by his son, and Mr. Betterton, chairman of the Commission, with whom was Mrs. Betterton, paid their visit to the Lake Country mines, and to the mines in the Durham area, last month. They arrived in the Lake District on the 11th and left on the 18th, and were shown round the district by Mr. Anthony Wilson, of the Thornthwaite lead mines. They visited Thornthwaite, Force Crag, Threlkeld, Carrock, Greenside, Nenthead, Allendale, and Weardale. Dr. Hatch and Mr. Betterton discussed the situation with the lead and zinc mine managers. Mr. Betterton took the greatest pains to master the position; and I think we shall find that the Government made a very good choice in appointing him Chairman of the Commission. Mr. Betterton appeared to realize that the difficulties created by the Government are very serious, and I am sure that he will do his best to rectify the injustice which we are suffering. Dr. Hatch seemed to be very much pleased by his reception and treatment during his tour of the district. Both the Controller and the Chairman were exceedingly interested in the flotation plant at Force Crag mine.

ZINC.—I have obtained some further information with respect to licences for the purchase of zinc concentrates. It appears that while the smelters are free to purchase zinc concentrates in any direction, the bonus on the production of spelter is only paid on the metal recovered from ores the purchase of which has been authorized by the Government Ore Purchasing Committee. The Board of Trade are not issuing these licences with any freedom, which seems to me a polite way of restricting purchases to the stocks bought by the Government from Australia. This arrangement with the smelters terminates on November 5, and after that date the smelters will have to sell their metal without any Government bonus. It is impossible to forecast what will happen, but it is quite possible that the Government may meet the difficulty by selling their concentrates at a low or normal price. The Government should in fairness to the home industry disclose the whole position, as the present uncertainty prevents any possibility of business. At one mine they are stocking zinc concentrate, and at another the company has over 1,000 tons dumped in a quarry adjacent to the railway station with very little if any chance of getting rid of it.

The conclusion is almost irresistible that this is a dying industry. There is stagnation in every direction. Why cannot the Government give us support until the Commission issue their report?

LEAD.—There is apparently a fairly active demand for lead concentrates if of good quality, but the returning charge on contracts of £5 per ton is the lowest that I think will apply during the coming year. With pre-war contracts and pig lead at £20 per ton the value of lead concentrates was £12. 19s. f.o.r. To obtain £12. 19s. under the new basis pig lead must be £24. 5s. per ton. This takes no account of the increased price of silver which modifies the position to some extent. The major part of the production in this country is, however, of ores containing about 4 oz. of silver.

THE MINES.—There is not much news this month concerning the activities of the mines in this district. Thornthwaite is turning out about 14 tons to 15 tons per week, and Threlkeld something like seven tons per week. Force Crag has very little output at the present time, and Greenside is distinctly below the average. The Vielle Montagne at Nenthead has now practically suspended all its underground work and is clearing up the mine preparatory to a permanent stoppage. The Allendale mines are not working on a very large scale, but the stoping ground developed during the past year is very rich. All the output is obtained by hand-picking. At Weardale the output is distinctly smaller than that secured during the past four or five years, but development is being very actively prosecuted, and there are a number of most encouraging features underground. Perhaps the most formidable difficulty the Durham mines have to contend with is that of labour. The minimum scale of wages has resulted in a reduction of output per man. That, however, is an experience shared by all mines.

ROYALTIES AND RATES.—I hope that the Lead and Zinc Mine-Owners' Association will bring to the notice of the Government the heavy burden under which the industry labours on account of the ridiculously high rates of royalty. One of the largest lead mines pays 10% of its total revenue to the royalty owners. This is based on the price of pig lead. During the war the company were actually paying £3 per ton on their output. I scarcely think that it is generally realized that high royalty rates involve heavy local rates. The basis on which the rates are assessed is the amount of royalty paid in the previous year. A royalty of £3 per ton necessitates a payment of rates to the extent of 16s. or 17s. per ton. At Thornthwaite in 1912 the royalty amounted to 4s. 9d., and the rates to 4d. The new method of assessment has been put into operation, and now the royalty is 13s. 4d. per ton and the rates 3s. 10d. That is a total of 16s. 5d. per ton on concentrates sold. And the rates are commencing to rise by leaps and bounds. In country places the rates range about 5s. in the £. Soon they will reach a substantially increased figure. It can be seen that the rating question will become a very serious matter. Every injustice will be multiplied. I quite anticipate that the local rates will soar from 5s. to 8s. The royalty rents were one of the things, I hear, which were discussed by Mr. Betterton, and I understand that the Chairman of the Commission intends when Parliament re-assembles to ask whether the Government intend to nationalize royalties. I append a copy of an average Cumberland lead and zinc mining royalty:

Lead.—1/50th part of the price of all lead ore when the selling price thereof is £9 or under; 1/45th part of the price of all lead ore when the selling price is above £9 and up to £10 per ton; 1/40th part of the price of all lead ore when the selling price is above £10 and up to £11 per ton; 1/35th part of the price of all lead ore when the selling price is above £11.

Blende.—1/80th part of the price of all blende when the selling price thereof is £3 per ton or under; 1/70th part of the price of all blende when the selling price is above £3 and up to £4 per ton; 1/60th part of the price of all blende when the selling price is above £4 and up to £5 per ton; 1/50th part of the price of all blende when the selling price is above £5 and up to £6 per ton; 1/45th part of the price of all blende when the selling price is above £6 per ton.

Copper and Other Minerals.—1/30th part of the price of all copper ore or other minerals except lead ore and blende.

PERSONAL

DR. J. O. ARNOLD has resigned the professorship of metallurgy in the University of Sheffield owing to ill-health. He has been a noted teacher and investigator at Sheffield for thirty years.

JEHU BERRY has resigned as general manager of the Wantage Engineering Co., Ltd.

H. C. BOYDELL has gone to Boston to prosecute some special geological studies at the Massachusetts Institute of Technology

A. O. BROWN, manager of Mina Santa Rosa, Huelva, is recovering from an attack of typhoid fever.

GILMOUR E. BROWN has come to London from Shanghai by way of the United States.

M. A. BRUCE is home from Nigeria.

CHARLES BUTTERS has retired from the firm of Chas. Butters & Co., Limited.

A. R. CANNING has returned from Nigeria.

THOMAS P. CARR has gone to Spain.

J. E. CLENNELL is now staying at Coombe Martin, North Devon.

W. R. DEGENHARDT has left for the United States.

CLEMENT DIXON, J.P., has been elected deputy mayor of Bulawayo.

G. W. FOSTER is here on leave from the Jos Tin Area, Nigeria.

R. G. HALL is returning to Burma.

HAROLD AND FREDERICK HAWKES have returned from Nigeria.

R. E. HORE has resigned as editor of the *Canadian Mining Journal*, and is succeeded by F. W. Gray.

D. J. INSKIPP is expected shortly from Burma.

T. G. IRONSIDE has been appointed acting manager and chemist for the South African Nitrate and Potash Corporation, and is now at Prieska, Cape Province.

LT.-COL. H. H. JOHNSON has returned from Kirkland Lake, Ontario.

FRANK C. LORING is here from Canada.

FRANK M. LUSH is home from Nigeria.

DORSEY A. LYON has been appointed chief metallurgist to the United States Bureau of Mines, succeeding F. C. Cottrell.

DR. T. R. MARSHALL has gone to Trinidad.

HARVEY S. MUDD left London on his return to the United States on September 19.

S. C. PARTRIDGE left London for Rhodesia on September 19.

ALEXANDER RICHARDSON, who has been serving with the Ministry of Munitions and the Department of Scientific and Industrial Research during the war, has resumed his duties on the staff of the Royal School of Mines.

W. R. RUMBOLD is home from Nigeria.

ARCHIBALD STARK has left for Spain.

G. GORDON THOMAS has been appointed manager for the Jos Tin Area (Nigeria), Ltd., and assistant general manager for the Tin Areas mining group in Nigeria. He will sail as soon as a passage is available.

V. R. TING, director of the Geological Survey of China, left San Francisco for home at the end of last month.

H. A. TITCOMB has left London to take up his residence in New York.

E. M. WESTON has been examining copper properties in Namaqualand for a Johannesburg syndicate.

CHARLES WILL WRIGHT has returned from America, and has gone to Rome, where he will open an office as consulting mining engineer.

B. W. HIPPISLEY, manager of the Jos mine, has been killed in a motor-cycle accident in Nigeria.

KENNETH AUSTIN MICKLE died at Melbourne on July 31. Captain Mickle was a young Australian metallurgist of great promise. He conducted many investigations in connection with flotation for the owners of the Potter patents, and subsequently undertook similar work for the Burma Corporation. He served in the British Army in France and became commanding officer of the Heavy Trench Mortar Brigade of the 9th Division. He received the D.S.O. and was mentioned three times in Sir Douglas Haig's despatches.

TRADE PARAGRAPHS

ELECTRO-METALS, LTD., of 56 Kingsway, London, W.C.2, a company associated with Boving & Co., Ltd., are makers in this country of the Ruggles rotary driers, which are suitable for drying pulverized coal.

TICKLE BROTHERS, Vulcan Foundry, Wigan, send us their catalogue of coal and ore-mining machinery, including hauling and winding engines, pumps, screens, conveyors, tipples, cages, etc.

THE OLIVER CONTINUOUS FILTER CO., of San Francisco, send us a new pamphlet, giving details of recent developments of their machines and particulars of notable installations.

THE WORTHINGTON PUMP & MACHINERY CORPORATION, of 115 Broadway, New York, and Queen's House, Kingsway, London, W.C.2, send us a pamphlet describing the direct-connected motor-driven Laidlaw feather-valve air-compressors; also an index to their bulletins and products.

N. GUTHRIDGE, LTD., of Sydney, N.S.W., are putting on the market a new concentrator called the "Curvilinear." This machine, though occupying a floor space of only 14 by 4 ft., has a capacity stated to be twice that of full-size tables. We hope to give particulars of its construction in a later issue. James Smith, of Camomile House, Camomile Street, London, E.C., is agent for the makers in this country.

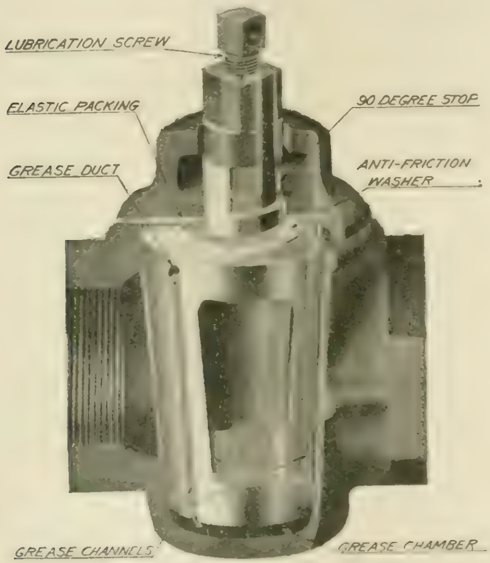
THE AGRICULTURAL AND GENERAL ENGINEERS, LTD., has been formed with a capital of £3,000,000 as an amalgamation of the following firms: Aveling & Porter, Ltd., of Rochester; E. H. Bentall & Co., Ltd., of Heybridge; Blackstone & Co., Ltd., of Stamford; Richard Garrett & Sons, Ltd., of Leiston; and James & Frederick Howard, Ltd., of Bedford. The head office will be at Central House, Kingsway, London, W.C.

THE BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO., LTD., of Trafford Park, Manchester, announces a change of name to the METROPOLITAN-VICKERS ELECTRICAL CO., LTD. From its inception in 1899 to 1917 the company was controlled by American shareholders. In the latter year the American holding was taken over by the Metropolitan Carriage Wagon & Finance Co., Ltd., which was later amalgamated with the Vickers interests.

In a recent issue we mentioned the Revergen regenerative gas furnace, put on the market by the DAVIS FURNACE CO., of Luton. The company send particulars of a record of work done in heating and maintaining the temperature in connection with the operation of case-hardening. The requirements in the test were that the material should be charged into a cold furnace, raised to 900°C., and maintained at that temperature for eight hours. The material consisted of automobile gear-wheels, packed in six boxes, and having a total weight of 713 lb. The required temperature was obtained in 70 minutes from lighting up. The gas consumed in obtaining the temperature was 925 cu. ft., or 1·29 ft. per lb of load, and the average consumption in maintaining the temperature was 312 ft. per hour, equal to 0·43 ft. per lb. The total gas consumption during the whole 9 hr. 10 min. was only 4·8 ft. per lb. of load.

THE GARRED-CAVERS CORPORATION, of 43 Exchange Place, New York, controls the Garred-Cavers patents for using pulverized coal in blast-furnaces. As recorded in our last issue, licences for these patents have been issued to the International Nickel Co., and the Tennessee Copper Co. More recently experiments have been carried out at the Cerro de Pasco copper mines, Peru, with satisfactory results. The existing blast-furnaces are to be modified accordingly, and new furnaces are to be erected.

THE MERRILL COMPANY, of 121 Second Street, San Francisco, have put on the market the Nordstrom Lubricated Plug Valve, the invention of S. J. Nordstrom



THE NORDSTROM LUBRICATED PLUG VALVE.

Mr. Nordstrom, when engaged in the design and operation of cyanide plants, was impressed with the defects of the usual types of plug cocks and gate valves. The principle of the invention is the combination in a plug valve of lubricant conduits and a lubricant chamber at the base of the plug so placed that when pressure is applied to the lubrication screw, this pressure operates to lift the plug from its seat and simultaneously to distribute lubricant over the bearing surfaces. A flexible packing is provided between the body of the valve and the cover. This packing also rests upon an anti-friction washer forming the thrust bearing of the plug. This thrust bearing is grooved concentrically to prevent leakage. The flexible packing furnishes the necessary elasticity to allow the plug to be forced from its seat for the purposes of lubrication and to force the plug back into its seat when the pressure in the lubricant chamber is released. The positions of the lubricating conduits and of the lubricant chamber are shown in the illustration. A stop is cast as an integral part of the plug and cover and is so placed that the lubricant conduits can never be exposed to the fluid passing through the valve. From the construction it will be evident that, no matter how firmly the plug may be stuck to the body of the valve, when force is applied to the lubricating screw a pressure is created in the grease chamber at the base of the plug and that this pressure must either raise the plug from its seat or else break the body of the valve. For greater convenience in assembling the valve, the cover bolts are provided with slotted lugs and a special nut is used to prevent the bolts from slipping when tightened. Suitable lubricants are supplied in the form of convenient cartridges which fit loosely into the lubricant conduit when the screw is removed. Several grades of lubricant are supplied to suit the special conditions under which the valves may be used. An inspection of the various makes of standard plug cocks, now on the market, will reveal the fact that the area of the opening in the plug is frequently no more than 60% of the area of the pipe. In other words, in many cases the effective area of a 3 in. plug cock will only be equal to the nominal area of a 2½ in. pipe. All types of the Nordstrom plug valve are so designed as to provide a full 100% opening in the plug.

FULLERTON, HODGART, & BARCLAY, LIMITED, of Paisley, have issued a description of their latest design of vertical high-speed air-compressors. The lower crank case, upper crank case, cross-head guides, and soleplate are constructed from the point of view of rigidity, leading to the elimination of vibration, and the preservation of the alignment. The trunk guides are cast in one piece with the distance-piece, the top part of the latter forming the bottom cover for the cylinder; there is thus perfect alignment throughout the whole working parts. The distance-piece is so arranged that the rod in contact with the crank chamber never comes into contact with the cylinder gland, thus eliminating the possibility of oil being carried into the cylinder from the piston rods. Large openings are provided to enable the packing glands, etc., to be easily accessible. A vertical tubular intercooler is fitted behind the compressor, the tubes being so arranged that in the event of damage they can be removed in a minimum of time. The cylinders are water-jacketed, the cooling water also passing through the end-cover jackets. The Fullerton patent valves are employed. These are of the strip-plate type and rectangular in form, the plates being made of a special tough steel having a very high elastic limit. The valve is such that for a given port area the absolute minimum weight of valve possible is obtained, there being no metal in the valve other than that required to cover the port. As each valve weighs only about 1 oz., it is eminently suitable for high-speed service, and has been the means of overcoming one of the serious objections often raised against high-speed air-compressors, that is, breakages of the valve plates through crystallization due to the weight of the valve employed. With this particular shape of valve it is possible to obtain the maximum of port area in the minimum of space, which allows of the valves being placed against the cylinder walls and so dispensing with large valve ports. The incoming and outgoing ports, as also the valves, are rectangular. The makers contend that this non-disturbance of the air throughout its passage up to the valves, through them into the cylinder, and out again, gives a minimum of heating during the period of admission and ejection, with a consequent gain in efficiency. A further distinctive feature of the compressor is that the inlet valves are on the opposite side of the cylinder to the outlet valves, thus obviating the incoming air having to pass through the heated walls of the port before admission to the cylinder. The valve-chest covers, giving access to the valves, are of very small dimensions; in fact, on the largest sizes they can be handled by one man. As evidence of this facility, it may be mentioned that a valve in a 3,000 cu. ft. size can be replaced by one man in half an hour. The main bearings, crank-pins, cross-head pins, etc,, are supplied with oil under pressure by a valveless pump. Very little lubricant is required on the air cylinders, and for this duty drop sight lubricators are fitted to the high-pressure and low-pressure cylinders, which in practice have been found to meet all requirements.

SHIPPING, ENGINEERING, AND MACHINERY EXHIBITION.

The railway strike, now fortunately over, deprived a large number of people, especially those living in the provinces, and indeed in all parts of the United Kingdom, from visiting one of the most interesting and comprehensive exhibitions ever held in London. The range of exhibits was a wide one, and touched engineering and shipbuilding in every branch. The educational side was not overlooked, as a reference to the ponderous catalogue, of nearly 500 pages and weighing over three pounds, will show.

It is many years since an exhibition has been held in London devoted to the shipping and engineering industries, and the idea of holding such an exhibition was conceived at a time when war was scarcely regarded as even a remote possibility. But it was rudely interrupted by the outbreak of war within a few weeks of the date actually fixed for the opening of the exhibition. For the time the scheme had naturally to be abandoned. Immediately after the Armistice was signed, a committee took the matter in hand again, with the result that a display has been secured which has taxed to the utmost the resources of the largest exhibition building in London. One thing that will strike the visitor, as perhaps it has never done before, will be how greatly the well-being of the nation is dependent upon the efficient maintenance of our Mercantile Marine.

Although the exhibition is international in its character (excluding, of course, all recent enemy countries), British firms to the number of about 350 predominate. Many allied and neutral countries send shows of a valuable type. The Netherlands Government, for the first time in the history of Holland, has made a determined effort to bring to the notice of the business world some of the resources of that country, and a visit to this section demonstrates its instructive and interesting character. Among the exhibits that arrested attention specially were models of the ports of Amsterdam and Rotterdam, each on the scale of 1 : 1,000, dredges and dry docks, steamships, elevators, coal transporters, marine engines, and many more. One exhibit that draws general attention shows a floating ship's safe, as used by the Netherlands Government for the conveyance of mails and valuables to their colonies. This automatically disconnects itself from a sinking ship, and while floating on the water sends up a rocket every hour for 12 hours; in addition, a sound signal is given and a light shown for three months from the moment it leaves the wreck.

In order to bring as clearly as possible to the mind of the ordinary man the uses of some of the exhibits, there were cinematograph shows and demonstrations given at several stands, showing the methods adopted for the purification of oils, acetylene welding, the use of ships' davits, and hoisting and pumping appliances of many kinds. Again, the visitor had brought under his notice all the details of a ship's construction, equipment, and fittings to the smallest parts, with models of warships and liners shown by leading shipbuilders and shipping companies, to say nothing of the Marconi apparatus and the diving tanks.

It was observed that many of the firms whose advertisements are to be found regularly in *The Mining Magazine* were well in front with their specialties. For instance, Messrs. HADFIELDS, Ltd., of Sheffield (Stand No. 39), in their department relating to dredges showed a complete tumbler, consisting of an "Era" manganese steel body shell fitted on a shaft of their forged steel; dredge buckets made throughout of their manganese steel, for harbour work and gold dredging; also dredge bucket pins, bushes, links, tumbler corner pieces, ladder rollers, &c., made of the same material. There was also an assortment of castings in manganese steel for use in various types of crushing machinery. They had also a casting of "Era" steel as used for naval purposes. Its weight is 12 tons and it is 7 in. in thickness, and has successfully withstood attack by 16 projectiles from 6 in. to 9·2 in. calibre, of various types of velocities ranging from 1,300 to 2,040 ft. per second, the total impact energy of the projectiles being no less than 50,000 ft.-tons. There was also a model of the Fitzalan Square Junction layout, Sheffield Corporation Tramways, built and put down in 1907 and relaid in May of this year, that is, after 12 years' continuous service in the centre of the city of Sheffield, and after no fewer than 13,500,000 tramcars had passed over it, equivalent approximately to an aggregate of about 137,000,000 tons of traffic, a sufficient recommendation for the qualities of their "Era" manganese steel.

THE METROPOLITAN VICKERS ELECTRICAL CO., LTD. (until recently known as the British Westinghouse Electric & Manufacturing Co.) (Stand No. 101), had on exhibition a high-pressure marine turbine cylinder, with rotor complete, for a total of 3,000 s.h.p., and a low-pressure turbine rotor of equal capacity; also steam nozzle boxes, turbine blades of all sizes, showing the process of manufacture, and turbine diaphragms, and a nozzle box for 20,000 h.p. turbine.

MESSRS. HOLMAN BROS., LTD., of Camborne (Stand Nos. 246-7-8), who specialize in air-compressors, rock-drills, pneumatic tools, and steel castings, have one specially useful tool on view, among several others. This is their chipping and caulking hammer, equipped with a chisel or caulking tool, blank, one end finished to fit the sleeve, also a special spanner for the handle and a nipple ½ in. gas for connecting the hose. They have four kinds, adapted (1) for light chipping and medium caulking; (2) for medium chipping and caulking; (3) for heavy chipping and caulking and for heading small rivets, hot or cold; and (4) for the heaviest type of chipping, suitable for removing cores from larger castings and for light riveting. With their hammer and sinker drills the firm broke the world's record in 1918 and 1919 for shaft-sinking, and in the world's contest at Johannesburg in 1910, among 20 competitors, they divided the first and second prizes of £5,000.

MESSRS. J. & E. WRIGHT, LTD., of the Universe Rope Works, Birmingham (Stand No. 164), showed hemp and wire rope of every description from the finest twine to wire rope for giant cranes in ordnance and shipyards. They claim to have a greater variety of construction in wire rope than probably any other manufacturer could produce. A very useful and inexpensive instrument they are bringing into prominence is a wire grip called the "Handyman." It claims to be compact, and requires no skill to attach.

THERMIT, LTD., who advise prospective clients not to wait for new parts as they are prepared to weld the old, certainly justify their claims, as a visit to their stand will show. They have a very comprehensive range of exhibits, and many that will arrest attention.

MESSRS. JOHN KIRKALDY, LTD., of Burnt Mill, Harlow, and 101 Leadenhall Street (Stand No. 127), have

DAILY LONDON METAL PRICES: OFFICIAL CLOSING PRICES ON
Copper, Lead, Zinc, and Tin per Long Tons; Silver

	Silver	Copper				Lead
		Standard Cash	Standard (3 mos)	Electrolytic	Best Selected	Soft Foreign
Sept.	d.	£ s. d. £ s. d	£ s. d. £ s. d	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
11	61¼	100 0 0 to 100 5 0	100 10 0 to 101 0 0	109 0 0 to 120 0 0	108 0 0 to 109 0 0	25 5 0 to 25 15 0
12	60¾	100 0 0 to 100 5 0	100 10 0 to 100 15 0	109 0 0 to 120 0 0	108 0 0 to 109 0 0	25 5 0 to 25 15 0
15	61½	101 0 0 to 101 5 0	101 10 0 to 101 15 0	110 0 0 to 121 0 0	108 0 0 to 109 0 0	25 5 0 to 25 15 0
16	61¾	101 0 0 to 101 5 0	101 10 0 to 101 15 0	110 0 0 to 123 0 0	109 0 0 to 110 0 0	25 7 6 to 26 0 0
17	61¾	101 0 0 to 101 5 0	101 15 0 to 102 0 0	110 0 0 to 123 0 0	109 0 0 to 110 0 0	25 12 6 to 26 5 0
18	61¾	101 0 0 to 101 5 0	101 15 0 to 102 0 0	110 0 0 to 123 0 0	109 0 0 to 110 0 0	25 12 6 to 26 5 0
19	62	100 15 0 to 101 0 0	101 5 0 to 101 10 0	110 0 0 to 123 0 0	109 0 0 to 110 0 0	25 12 6 to 26 7 6
22	62½	100 5 0 to 100 10 0	100 15 0 to 101 0 0	110 0 0 to 121 0 0	109 0 0 to 110 0 0	25 10 0 to 26 0 0
23	62⅝	99 15 0 to 100 0 0	100 10 0 to 100 15 0	110 0 0 to 121 0 0	109 0 0 to 110 0 0	25 12 6 to 26 0 0
24	63	99 15 0 to 100 0 0	100 5 0 to 100 10 0	110 0 0 to 121 0 0	109 0 0 to 110 0 0	25 12 6 to 26 2 6
25	63⅜	100 5 0 to 100 10 0	100 10 0 to 100 15 0	110 0 0 to 121 0 0	109 0 0 to 110 0 0	25 12 6 to 26 2 6
26	63⅜	102 0 0 to 102 5 0	101 10 0 to 101 15 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	25 12 6 to 26 5 0
29	62⅛	101 0 0 to 101 2 6	100 10 0 to 100 15 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	25 12 6 to 26 2 6
30	64	102 5 0 to 102 10 0	101 5 0 to 101 10 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	25 12 6 to 26 2 6
Oct.						
1	64	103 0 0 to 103 5 0	101 5 0 to 101 15 0	110 0 0 to 120 0 0	109 0 0 to 110 0 0	25 12 6 to 26 2 6
2	64¼	103 2 6 to 103 5 0	101 15 0 to 102 0 0	112 0 0 to 120 0 0	109 0 0 to 110 0 0	25 15 0 to 26 12 6
3	63	103 5 0 to 103 10 0	101 15 0 to 102 0 0	112 0 0 to 120 0 0	110 0 0 to 111 0 0	25 15 0 to 26 10 0
6	64	104 0 0 to 104 5 0	103 0 0 to 103 5 0	113 0 0 to 120 0 0	110 0 0 to 111 0 0	25 17 6 to 26 15 0
7	63	103 15 0 to 104 0 0	103 0 0 to 103 10 0	113 0 0 to 120 0 0	111 0 0 to 112 0 0	26 0 0 to 27 0 0
8	63⅜	103 15 0 to 104 0 0	103 5 0 to 103 10 0	113 0 0 to 120 0 0	111 0 0 to 112 0 0	26 15 0 to 28 0 0
9	63	104 0 0 to 104 5 0	103 15 0 to 104 0 0	113 0 0 to 120 0 0	111 0 0 to 112 0 0	27 12 6 to 28 10 0
10	62⅞	104 15 0 to 105 0 0	104 10 0 to 104 15 0	114 0 0 to 121 0 0	113 0 0 to 114 0 0	27 12 6 to 28 7 6

an attractive show, with high and low-pressure distillers, evaporators, feed heaters and filters, of the coil, pressure, and suction type, petrol or paraffin launch motors, an evaporating and distilling plant as supplied to the Navy, and a cold chamber with a ½ ton CO_2 compressor, condenser, evaporator, and air-circulating fan, and a small ice-making plant with ½ ton compressor and cold cupboard complete.

Want of space precludes us from making further mention of other exhibits; these will be dealt with in the next issue.

METAL MARKETS

COPPER.—The Government stocks of copper in this country on September 1 amounted to 28,049 tons, thus showing a decrease on the month of 9,181 tons. This return, which was very satisfactory as illustrating the quantities of copper going into consumption in addition to the metal which had been imported, had no effect upon the market, which continues to be largely dominated by conditions prevailing on the other side of the Atlantic. The large producers in America still have the position pretty much in their own hands, but the situation there has not had quite so strong an appearance lately. This seems to be partly due to the exchange situation militating against any important export movement to Europe, while the strike of steel workers in America has also somewhat affected the sentiment. Obviously, if this should be protracted, constructional work will be held up, with a consequent hindrance to the expansion of the demand for copper. With these factors in mind, it is not altogether surprising that there should have been some shading seen in the prices cabled from New York. This has been attributed to re-selling by speculators and dealers, and to realizing by smaller producers, who were perhaps less able than the larger ones to finance their stocks: but whether the big interests are cutting their figures is still a matter of some doubt. On this side dealers have experienced only a moderate trade with consumers. Possibly this was partly due to there being important quantities of scrap in the market. As regards electrolytic wirebars, this description still maintains a considerable premium over ingots, and owing to the margin between the two, the London Metal Exchange started the practice of quoting a separate official price for wirebars. The standard market has only been moderately active, there having been little to induce fresh enterprise recently. A feature toward the end of September was the establishment of a premium on near metal, whereas a contango on forward delivery had previously ruled.

Average prices of cash standard copper: September 1919, £100. 17s. 5d.; September 1918, £122. 5s.; August 1919, £97. 11s. 5d.; August 1918, £122. 5s.

TIN.—This metal has seen a very considerable amount of activity during the period under review, and an important business has been moving on the London Metal Exchange. The inquiry for export to America and elsewhere created a good demand for standard, and as the buying pressure was for the most part for prompt metal, cash standard ruled at a considerable premium, in spite of the fact that a good deal of speculative buying of forward was also in evidence. The light state of stocks in this country naturally assisted in maintaining the high level of prices for near positions. The renewed activity in the South Wales tinplate industry also stimulated business with home consumers. The East has done a fair trade, but dealings there were somewhat spasmodic, sellers often showing considerable reserve, while at one moment business was interrupted owing to fears in that quarter that there might be some alteration in the exchange rates. On an assurance by the Straits Government that there was no such intention, dealings were resumed. Toward the latter part of September the outbreak of the steel strike in America caused considerable realizing on the London market and prices gave way. This selling was believed to be liquidation here by America of parcels previously bought for shipment. The metal coming on offer was well absorbed, and the market was steadied only to become weak again on the outbreak of the railway strike here. Toward the end of the month a feature was the contraction in the backwardation on forward metal. An interesting development in the last part of September was the resumption of sales of Banca tin in Holland by the Netherlands Trading Co. About 5,400 slabs were offered, the sale being by tender. Only a small portion of this seems to have been sold, but at a

THE LONDON METAL EXCHANGE.
per Standard Ounce.

Zinc (Spelter)	Standard Tin — Cash	Standard Tin — 3 mos.
£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
40 15 0 to 41 15 0	279 0 0 to 280 0 0	272 15 0 to 273 0 0
40 15 0 to 41 15 0	282 10 0 to 283 10 0	274 10 0 to 275 0 0
41 10 0 to 42 10 0	285 10 0 to 286 10 0	280 0 0 to 280 10 0
41 15 0 to 42 10 0	287 0 0 to 287 10 0	279 10 0 to 279 15 0
41 15 0 to 42 10 0	289 0 0 to 289 10 0	279 5 0 to 279 10 0
41 15 0 to 42 10 0	285 10 0 to 286 0 0	278 15 0 to 279 0 0
41 10 0 to 42 5 0	280 10 0 to 281 0 0	275 10 0 to 276 0 0
41 10 0 to 42 0 0	278 0 0 to 278 10 0	273 10 0 to 273 15 0
40 15 0 to 41 15 0	276 0 0 to 277 0 0	273 10 0 to 273 15 0
41 10 0 to 42 5 0	277 0 0 to 277 10 0	274 15 0 to 275 0 0
41 10 0 to 42 5 0	276 10 0 to 277 0 0	274 10 0 to 274 15 0
41 0 0 to 41 15 0	277 5 0 to 277 10 0	275 15 0 to 276 0 0
41 0 0 to 41 15 0	272 0 0 to 272 10 0	270 0 0 to 270 10 0
40 15 0 to 41 10 0	274 5 0 to 274 15 0	272 5 0 to 272 10 0
40 15 0 to 41 10 0	271 10 0 to 272 0 0	270 10 0 to 271 0 0
41 0 0 to 41 15 0	277 0 0 to 277 10 0	275 5 0 to 275 15 0
41 0 0 to 41 15 0	278 0 0 to 278 10 0	276 5 0 to 276 10 0
41 5 0 to 42 0 0	282 15 0 to 283 0 0	282 0 0 to 282 5 0
42 0 0 to 43 0 0	282 0 0 to 282 5 0	282 10 0 to 282 15 0
41 15 0 to 42 15 0	281 0 0 to 281 5 0	281 15 0 to 282 0 0
42 10 0 to 43 10 0	281 0 0 to 281 5 0	282 0 0 to 282 5 0
42 15 0 to 43 10 0	282 15 0 to 283 0 0	284 0 0 to 284 10 0

high figure, the price realized being about the equivalent of £300 per ton, in warehouse Amsterdam.

Average prices of cash standard tin: September 1919, £280. 4s.; September 1918, £343. 19s. 1d.; August 1919, £271. 8s.; August 1918, £380. 16s. 8d.

LEAD.—The market for this metal on 'Change saw a fair amount of activity during September. While to a certain extent this was due to speculative purchases of forward metal, business was further stimulated by the fact that the Government withdrew from the market for a time, and demand was thus diverted to the Metal Exchange. The Government stocks are stored at some points which are difficult of access, and in view of the large sales made by them, operations at the stores became somewhat congested and a period of abstention from selling was considered advisable. They have since re-entered the market, but as they were quoting fairly full figures, their resumption of selling did not adversely affect values. Business with consumers has only been on a moderate scale, but some further inquiry has been seen from Japan. America continues to be pretty firm, and free offerings from that quarter seem impossible at present, while there do not seem to be any other supplies likely to press on the market. The outlook seems therefore fairly sound. The Government stocks of soft pig lead in this country on September 1 amounted to 84,057 tons, thus showing a decrease on the month of 23,953 tons, while some of the existing stocks are understood to be already sold for forward delivery.

Average prices of soft pig lead: September 1919, £25. 12s. 7d.; September 1918, £29; August 1919, £25. 1s. 7d.; August 1918, £29.

SPELTER.—Although there have been no very important price movements in this market recently, the sentiment in regard to the metal has varied somewhat. At one time some selling was seen, induced by the fear of German spelter coming out in volume, but latterly this apprehension seems to have been largely dispelled. It is understood that some business has actually been done in German spelter, but it appears to have been mostly done with neutral countries, to which Germany had previously either sold or forwarded the metal for safe keeping. More of this spelter may possibly still come out, but general opinion does not favour the probability of important supplies, such as would affect the market, coming direct from Germany itself. Production there is being interfered with by labour troubles, as well as in some quarters the difficulty of procuring the necessary ores, and the belief is that neither the output nor stocks are such as to warrant the expectation of any big export movement of the metal. America has been somewhat easier, partly owing to the steel strike there, and the parity is now near that of the London market. The home Government have maintained their selling prices, which are above those ruling in the open market, and in view of the somewhat precarious state of the smelting industry in this country, the outlook, so far as prices go, seems to depend on America. The Government stocks of g.o.b. spelter on September 1 were 20,041 tons, or a decrease of 3,127 tons on the month, while those of refined spelter on September 1 were 10,963 tons, or a decrease of 1,173 tons since August 1.

Average prices of spelter: September 1919, £41. 8s. 5d.; September 1918, £52; August 1919, £39. 16s. 9d.; August 1918, £52.

ZINC DUST.—Spot supplies of Australian have been scarce. The price is £68 to £70 per ton c.i.f. U.K. for Australian high-grade 88 to 92% metallic zinc.

ANTIMONY.—The market has been firm with a fair business moving, partly for export, and the price of English regulus has been maintained at £45 per ton. Meanwhile the spot parcels of foreign offering at less than English seem to have been cleared. The Government stocks of regulus on September 1 were 3,386 tons, showing a decrease on the month of 1,025 tons.

ARSENIC.—The market has been quiet. The quotation for white is about £59 to £60 delivered London.

BISMUTH.—12s. 6d. nominal per lb.

CADMIUM.—6s. 6d. to 6s. 9d. per lb.

ALUMINIUM.—£150 per ton for the home trade.

NICKEL.—£205 per ton for the home trade, and £210 for export.

COBALT METAL.—12s. 6d. to 13s. per lb.

COBALT OXIDE.—7s. 9d. to 8s. 9d. per lb.

PLATINUM.—450s. nominal per oz.

PALLADIUM.—500s. nominal per oz.

QUICKSILVER.—£21. 10s. to £22. per bottle.

SELENIUM.—12s. to 15s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER.—£40 to £42 per ton.

MANGANESE ORE.—Business quiet. Prices of Indian are firm at 2s. 3d. upward per unit c.i.f. U.K.

TUNGSTEN ORES.—Wolframite 65% 32s. 6d. per unit, and scheelite 65% 32s. 6d. per unit.

CHROME ORES.—No quotation.

MOLYBDENITE.—85%, 75s. per unit.

SILVER.—The market has been very strong, chiefly owing to Chinese buying, coupled with short supplies, and at the end of September the price of standard bars touched a new high record at 64d. per oz.

CORUNDUM.—Nominal.

GRAPHITE.—80%, £35 to £40 c.i.f. U.K.

IRON & STEEL.—The Cleveland pig iron market has not been particularly active and the outbreak of the ironfounders' strike seems likely to accentuate the quietness. Foundry iron has continued scarce, but the lessened requirements at home may make further export business possible, there being a good inquiry for overseas markets. Prices all round have been steady. In steel, and manufactured products generally, works were well employed, but what the effect of the railway strike may be is impossible to forecast. Meanwhile the demand has been mainly for shipbuilding and general constructional work, and such materials as plates have been very difficult to procure.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
July, 1918	716 010	20,189	736,199	3,127,174
August	719,849	20,361	740,210	3,144,211
September	686,963	21,243	708,206	3,008,267
October	667,955	11,809	679,764	2,887,455
November	640,797	17,904	658,701	2,797,983
December	630,505	10,740	641,245	2,723,836
Year 1918	8,197,959	221,734	8,419,693	35,768,658
January, 1919	662,205	13,854	676,059	2,871,718
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,9[illegible]6
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,7[illegible]9

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1918	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	196,294
September 30	179,399	12,108	4,889	196,395
October 31	173 153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637
January 31, 1919	160,599	11,848	3,539	175 986
February 28	172,359	11,868	4,264	188,491
March 31	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190 880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s d	s. d.	s. d.	£
July, 1918	2,167,869	27 10	21 [illegible]	6 6	702,360
August	2,1[illegible]8,431	28 1	21 7	6 [illegible]	676,146
September	2,060,635	28 2	22 0	5 10	600,330
October	2,015,144	28 0	22 5	5 [illegible]	551,774
November	1,899,925	28 5	23 1	5 1	480,102
December	[illegible]	28 7	23 0	5 6	507,860
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129
January, 1919	1,942,3[illegible]9	28 9	23 0	5 8	547,793
February	1,816,352	28 9	23 2	5 6	498,204
March	2,082,469	28 [illegible]	22 6	5 6	573,582
April	1,993,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715
June	2 032,169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 [illegible]	611,118

Production of Gold in Rhodesia and West Africa.

	Rhodesia. 1918	Rhodesia. 1919	West Africa. 1918	West Africa. 1919
	£	£	£	£
January	253,807	211,917	107,863	104,063
February	232,023	220,885	112,865	112,616
March	230,023	225,808	112,605	112,543
April	239,916	213,160	117,520	109,570
May	239,205	218,057	126,290	100,827
June	225,447	214,215	120,273	106,612
July	251,740	214,919	117,581	102,467
August	257,096	207 339	120,526	—
September	247,885	—	115,152	—
October	136,780	—	61,461	—
November	145,460	—	108,796	—
December	192,870	—	112,621	—
Total	2,652,250	1,726,300	1,333,553	748,698

Transvaal Gold Outputs.

	August, 1919 Treated	August, 1919 Value
	Tons	£
Aurora West	15,000	16,364
Bantjes	—	—
Barrett	—	720
Brakpan	46,700	87,805
City & Suburban	18,908	26,718
City Deep	55,800	102,109
Cons. Langlaagte	40,000	53,839
Cons. Main Reef	47,800	74,351
Crown Mines	176,000	237,195
Durban Roodepoort Deep	25,000	32,448
East Rand P.M.	125,000	151,623
Ferreira Deep	34,400	50,952
Geduld	42,800	65,254
Geldenhuis Deep	45,400	56,168
Ginsberg	—	—
Glynn's Lydenburg	2,950	5,596
Goch	14,780	11,107
Government G.M. Areas	107,000	197,627
Heriot	10,880	14,394
Jupiter	25,000	25,952
Kleinfontein	47,800	69,730
Knights Central	22,400	31,459
Knights Deep	91,600	73,597
Langlaagte Estate	40,060	48,603
Luipaard's Vlei	21,100	20,421
Meyer & Charlton	15,000	40,954
Modderfontein	70,000	160,360
Modderfontein B	53,500	114,317
Modderfontein Deep	41,300	91,491
New Unified	11,300	11,966
Nourse	38,450	49,568
Primrose	18,000	18,083
Princess Estate	20,000	28,124
Randfontein Central	146,200	171,483
Robinson	39,600	41,886
Robinson Deep	53,500	73,004
Roodepoort United	23,000	20,604
Rose Deep	51,700	60,392
Simmer & Jack	56,900	57,189
Simmer Deep	43 600	50,013
Springs	37,350	65,596
Sub Nigel	10,100	27,542
Transvaal G.M. Estates	15,880	26,140
Van Ryn	29,200	31,943
Van Ryn Deep	47,150	109,839
Village Deep	42,800	64,041
Village Main Reef	17,900	24,738
West Rand Consolidated	31,150	38,369
Witwatersrand (Knights)	30,700	38,504
Witwatersrand Deep	29,700	35,194
Wolhuter	29,700	34,421

West African Gold Outputs.

	August, 1919 Treated	August, 1919 Value
	Tons	£
Abbontiakoon	7,393	15,849
Abosso	6,500	12,050
Ashanti Goldfields	8,441	37,533
Offin River	—	332
Prestea Block A	14,632	23,953
Taquah	4,742	12,068
Wassau	—	—

Rhodesian Gold Outputs.

	August, 1919 Treated	August, 1919 Value
	Tons	£
Antelope	3,260	4,205
Cam & Motor	—	—
Eldorado Banket	806	3,193
Falcon	15,339	24,429*
Gaika	3,010	5,615
Globe & Phœnix	6,314	7,016†
Lonely Reef	4,700	25 312
Rezende	5,500	12,768
Rhodesia, Ltd.	128	208
Shamva	54,518	37,499
Transvaal & Rhodesian	1,800	4,300
Wanderer	—	—

* Gold, Silver and Copper; † Ounces Gold.

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
August, 1918	*	76,156	*	*
September	*	74,057	*	*
October	*	71,439	*	*
November	1,444	70,711	72,155	306,494
December	2,739	61,314	64,053	272,208
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	*nil*	66,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316 862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410

* By direction of the Federal Government the export figures from July, 1916, to November, 1918, were not published.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1918	1919	1918	1919	1918	1919
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	25,000	18,000
February	58,113	46,955	45,470	43,330	28,000	24,000
March	65,412	40,267	48,020	48,000	30,000	16,000
April	29,620	63,818	47,600	61,200	30,000	24,000
May	87,885	37,456	46,740	38,200	45,000	16,000
June	45,765	41,465	51,420	44,600	32,000	17,000
July	64,347	37,395	51,000	42,060	25,000	22,000
August	61,163	—	44,600	49, 00	21,000	20,000
September	65,751	—	45,900	—	32,000	—
October	*	—	54,400	—	40,000	—
November	*	—	38,200	—	25,000	—
December	70,674	—	56,281	—	38,000	—
Total	674,655	304,292	578,213	364,190	370,000	157,000

* Figures not received.

Australasian Gold Outputs.

	August, 1919	
	Treated	Value
	Tons	£
Associated	5,401	8,654
Associated Northern Blocks { Iron Duke	—	1,287*
Associated Northern Blocks { Victorious	—	—
Blackwater	2,674	5,414
Bullfinch	—	—
Golden Horseshoe	—	—
Great Boulder Prop.	1,771	5,251
Ivanhoe	—	—
Kalgurli	2,595	4,756
Lake View & Star	—	—
Mount Boppy	2,500	—
Oroya Links	1,364	12,551†
Progress	1,300	1,726
Sons of Gwalia	13,716	19,032
South Kalgurli	5,736	8,587
Talisman	310	1,305
Waihi	15,532	25 016‡
Waihi Grand Junction	3,190	4,627‡

* Surplus; † Total receipts; ‡ Gold and Silver to September 6.

Miscellaneous Gold Output.

	August, 1919	
	Treated	Value
	Tons	£
Barramia (Sudan)	—	—
Esperanza (Mexico)	18,449	2,318††
Frontino & Bolivia (Colombia)	2,450	9,076
Nechi (Colombia)	31,338*	24,020†
Ouro Preto (Brazil)	7,600	13,300
Pato (Colombia)	74,918*	61,435†
Philippine Dredges (Philippine Islands)	—	203§
Plymouth Cons. (California)	9,300	12,260
St. John del Rey (Brazil)	—	37,000
Santa Gertrudis (Mexico)	36,600	32,900††
Sudan Gold Field (Sudan)	—	2,539

* Cubic yards. † Dollars. § Ounces, fineness not stated.
†† Profit, gold and silver.

Production of Gold in India.

	1916	1917	1918	1919
	£	£	£	£
January	192,150	190,047	176,030	162,270
February	183,264	180,904	173,343	153,775
March	186,475	189,618	177,950	162,790
April	192,208	185,835	176,486	162,550
May	193,604	184,874	173,775	164,080
June	192,469	182,426	174,375	162,996
July	191,404	179,660	171,950	163,795
August	192,784	181,005	172,105	160,840
September	192,330	183,630	170,360	—
October	191,502	182,924	167,740	—
November	192,298	182,388	157,176	—
December	205,164	190,852	170,630	—
Total	2,305,652	2,214,163	2,061,920	1,195,096

Indian Gold Outputs.

	August, 1919	
	Tons Treated	Fine Ounces
Balaghat	3,300	2,135
Champion Reef	11,850	6,904
Hutti (Nizam's)	—	900
Jibutil	—	—
Mysore	21,595	13,010
North Anantapur	800	1,079
Nundydroog	8,775	6,458
Ooregum	12,900	7,364

Base Metal Outputs

		August, 1919
Arizona Copper	Short tons copper	1,450
British Broken Hill	Tons lead concentrate	—
	Tons zinc concentrate	—
	Tons carbonate ore	—
Broken Hill Block 10	Tons lead concentrate	—
	Tons zinc concentrate	—
Burma Corp.	Tons refined lead	1,421
	Oz. refined silver	163,849
Cordoba Copper		—
Fremantle Trading	Long tons lead	—
North Broken Hill	Tons lead	—
	Oz. silver	—
Poderosa	Tons copper ore	116
Rhodesian Broken Hill	Tons lead and zinc	1,089
Tanganyika	Long tons copper	2,279
Tolima	Tons silver-lead concentrate	60
Zinc Corp.	Tons zinc concentrate	—
	Tons lead concentrate	—

Imports of Ores and Metals into United Kingdom.

		Sept. 1919	Year 1919
Iron Ore	Tons	266,385	4,124,625
Manganese Ore	Tons	11,263	232,268
Copper and Iron Pyrites	Tons	26,581	230,450
Copper Ore	Tons	84	10,468
Copper Precipitate	Tons	235	9,507
Copper Metal	Tons	9,736	91,450
Tin Concentrate	Tons	1,701	25,839
Tin Metal	Tons	2,617	14,684
Lead, Pig and Sheet	Tons	11,074	184,317
Zinc (Spelter)	Tons	6,055	73,326
Quicksilver	Lb.	449,928	2,524,719
Zinc Oxide	Cwt.	4,902	109,208
Barytes	Cwt.	53,426	324,481
Phosphate	Tons	22,423	260,005
Brimstone	Cwt.	986	115,775
Boracic Compounds	Cwt.	34,576	206,765
Nitrate of Potash	Cwt.	2,000	123,879
Petroleum:			
Crude	Gallons	—	4,866,734
Lamp Oils	Gallons	15,313,922	123,265,347
Motor Spirit	Gallons	14,770,911	155,705,[illegible]
Lubricating Oils	Gallons	6,117,489	46,659,974
Gas Oil	Gallons	4,260,521	17,529,518
Fuel Oil	Gallons	30,795,402	185,978,437
Total Petroleum	Gallons	71,257,955	534,006,002

UNITED STATES METAL EXPORTS AND IMPORTS.

Exports.	June Tons.	July Tons.	Imports.	June Tons.	July Tons.
Copper Ingots	10,826	18,917	Antimony	722	645
Copper Tubes	248	149	Tin Con.	—	1,975
Copper Sheets	229	195	Tin	50	897
Copper Wire	2,127	2,468	Manganese Ore	31,550	15,585
Lead, Pig	7,492	2,367	TungstenCon	338	452
Zinc	10,730	8,842	Pyrites	50,545	63,088
Zinc Sheets	746	896			

OUTPUTS OF TIN MINING COMPANIES.
In Tons of Concentrate.

	Year 1918 Tons	August 1919 Tons	Year 1919 Tons
Nigeria:			
Abu	33	1½	15
Anglo-Continental	207	—	95
Associated Nigerian	—	40	40
Benue	146	3	56
Berrida	—	—	1
Bisichi	275	22	112
Bongwelli	17	8	37
Dua	60	5	45
Ex-Lands	342	32	240
Filani	37	6	20
Forum River	274	15	110
Gold Coast Consolidated	30	3	24
Gurum River	99	8	73
Jantar	141	8	73
Jos	228	12	148
Kaduna	178	9	129
Kaduna Prospectors	—	5	41
Kano	60	13	106
Kassa-Ropp	133	—	84
Keffi	118	—	30
Kuru	12	20	193
Kuskie	21	—	4
Kwall	108	—	7
Lower Bisichi	99	3	55
Lucky Chance	27	2	21
Minna	40	5	26
Mongu	476	45	357
Naraguta	478	38	253
Naraguta Extended	280	30	169
New Lafon	198	—	125
Nigerian Tin	87	—	25
Ninghi	—	6	31
N.N. Bauchi	435	35	240
Offin River	120	4	40
Rayfield	689	50	447
Ropp	836	103	699
Rukuba	132	6	29
South Bukeru	94	3	35
Sybu	40	2	22
Tin Areas	96	8	50
Tin Fields	108	13	114
Toro	17	—	3
Union & Rhodesian Trust	—	6	6
Federated Malay States:			
Chenderiang	179	—	52
Gopeng	979	51	557
Idris Hydraulic	136	16	148
Ipoh	245	17	107
Kamunting	236	—	96
Kinta	478	39	291
Kledang	28	—	10
Lahat	399	44	285
Malayan Tin	730	45	443
Pahang	1,877	184	1,442
Rambutan	207	15	105
Sungei Besi	408	46	256
Tekka	508	36	299
Tekka-Taiping	400	30	216
Tronoh	1,364	136	986
Tronoh South	133	—	—
Cornwall:			
Cornwall Tailings	140	—	—
Dolcoath	787	50	494
East Pool	1,336	67	680
Geevor	352	—	186
South Crofty	598	44	383
Other Countries:			
Aramayo Francke (Bolivia)	1,816	144	1,397
Briseis (Tasmania)	327	15	157
Deebook (Siam)	398	30	190
Mawchi (Burma)	658	56	521
Porco (Bolivia)	227	24	186
Renong (Siam)	615	64	619
Rooiberg Minerals (Transvaal)	335	10	196
Siamese Tin (Siam)	989	—	382
Tongkah Harbour (Siam)	1,528	102	774
Zaaiplaats (Transvaal)	563	9	323

NIGERIAN TIN PRODUCTION.
In long tons of concentrate of unspecified content.
Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	485	417	531	667	678	613
February	469	358	528	646	668	623
March	502	418	547	655	707	606
April	482	444	486	555	584	546
May	480	357	536	509	525	483
June	460	373	510	473	492	484
July	432	455	506	479	545	473
August	228	438	498	551	571	565
September	289	442	535	538	520	572
October	272	511	584	578	491	—
November	283	467	679	621	472	—
December	326	533	654	655	518	—
Total	4,708	5,213	6 594	6,927	6,771	4,400

TOTAL SALES OF TIN CONCENTRATE AT REDRUTH TICKETINGS.

	Long tons	Value	Average
July 1	170½	£34,035	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	146¼	£33,816	£231 4 6
August 12	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	142½	£28,793	£202 1 2
September 24	145¾	£29,639	£203 7 2
October 7	136½	£27 037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	141¼	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	166¾	£25,170	£150 19 0
December 16	175½	£26 032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918	4,094	£786,541	£192 0 0
January 13, 1919	160	£20,838	£130 11 0
January 27	135½	£17,000	£125 10 7
February 10	153	£17,441	£113 19 10
February 24	142	£15,015	£105 14 10
March 10	144½	£18,123	£125 8 5
March 24	148½	£17 877	£120 7 8
April 7	134½	£15,258	£111 8 10
April 22	134¼	£15,023	£111 18 1
May 5	129	£14,919	£115 13 2
May 19	126½	£15,844	£125 5 0
June 2	140	£17,185	£122 15 0
June 16	139	£17,206	£123 15 9
June 30	136	£16,782	£123 8 0
July 14	145	£18,250	£125 17 3
July 28	122	£16,939	£138 16 11
August 11	127½	£17,125	£134 6 5
August 25	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19 557	£144 6 9
October 6	72	£10,887	£150 17 4

DETAILS OF REDRUTH TIN TICKETINGS.

	September 8 Tons Sold	September 8 Realized per ton £ s. d	September 22 Tons Sold	September 22 Realized per ton £ s. d.
E. Pool & Agar, No. 1	10	145 5 0	11	145 12 6
„ „ No. 1a	10	143 15 0	11	145 0 0
„ „ No. 1b	10	143 15 0	11	145 5 0
„ „ No. 1c	—	—	—	—
Dolcoath, No. 1	8	155 0 0	8	150 0 0
„ No. 1a	8	155 10 0	8	150 15 0
„ No 1b	9	155 10 0	9	150 15 0
„ No. 2	3½	75 17 6	3½	77 15 0
„ A	1½	133 0 0	1½	133 12 6
South Crofty, No. 1	11	145 0 0	10	145 10 0
„ „ No. 1a	11	146 0 0	11	144 0 0
Grenville Utd., No. 1	8	140 17 6	8	141 7 6
„ „ No. 1a	8	140 17 6	7	142 10 0
„ „ No. 2	3	65 10 0	—	—
Tincroft Mines, No. 1	6	156 10 0	5½	152 0 0
„ „ No. 1a	6	157 10 0	6	152 0 0
Levant Mines, No. 1	—	—	10	150 15 0
„ „ No. 1a	—	—	10	151 15 0
Wheal Bellan	2½	146 10 0	—	—
Jumbil 1	—	—	2½	121 5
„ 2	—	—	2½	109 15
Total	115½		135½	

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons. *Figures not published.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January	4,395	4,316	3,558	3,149	3,765
February	3,780	3,372	2,755	3,191	2,673
March	3,653	3,696	3,286	2,608	2,819
April	3,619	3,177	3,251	3,308	2,855
May	3,823	3,729	3,413	3,332	3,404
June	4,048	3,435	3,489	2,950	2,873
July	3,544	3,517	3,253	3,373	3,756
August	4,046	3,732	3,413	3,259	2,955
September	3,932	3,636	3,154	3,166	3,161
October	3,797	3,681	3,436	2,870	—
November	4,059	3,635	3,300	3,131	—
December	4,071	3,945	3,525	3,023	—
	46,767	43,871	39,833	37,370	28,261

STOCKS OF TIN

Reported by A. Strauss & Co. Long Tons.

	August 31, 1919	Sept. 30, 1919
	Tons	Tons
Straits and Australian Spot	573	523
Ditto, Landing and in Transit	1,010	2,522
Other Standard, Spot and Landing	433	275
Straits, Afloat	4,664	3,585
Australian, Afloat	252	225
Banca, in Holland	1,144	1,370
Ditto, Afloat	673	2,293
Billiton, Spot	—	—
Billiton, Afloat	—	70
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	840	2,071
Total Afloat for United States	7,648	8,542
Stock in America	920	1,515
Total	18,157	21,292

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.

Reported by A. Strauss & Co. Long tons.

	August 1919	Sept. 1919
	Tons	Tons
Shipments from:		
Straits to U.K.	4,164	1,500
Straits to America	3,825	3,615
Straits to Continent	840	350
Straits to Other Places	1,363	742
Australia to U.K.	100	350
U.K. to America	1,720	1,369
Imports of Bolivian Tin into Europe	839	29
Supply:		
Straits	8,829	5,465
Australian	100	350
Billiton	82	—
Banca	2,682	—
Standard	1,129	1,494
Consumption:		
U K. Deliveries	1,333	1,142
Dutch „	60	54
American „	4,345	4,825
Straits, Banca & Billiton, Continental Ports, etc.	875	917
Straits in hands of Malay Government	—	—
„ controlled by U.S. Government	—	—
„ „ „ French and Italian Governments	—	—
Banca in Trading Company's hands	—	—

PRICES OF CHEMICALS. Oct. 3.

		£	s.	d.
Alum	per ton	17	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous	per lb.		1	10
,, 0·880 solution	per ton	33	0	0
,, Carbonate	per lb.			6½
,, Chloride of, grey	per ton	47	0	0
,, ,, ,, pure	per cwt.	4	0	0
,, Nitrate of	per ton	60	0	0
,, Phosphate of	,,	110	0	0
,, Sulphate of	,,	19	0	0
Antimony Sulphide	per lb.		1	3
Arsenic, White	per ton	60	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	55	0	0
Bleaching Powder, 35% Cl.	,,	15	0	0
Borax	,,	39	0	0
Copper, Sulphate of	,,	41	0	0
Cyanide of Sodium, 100%	per lb			10
Hydrofluoric Acid	,,			7
Iodine	,,		16	0
Iron, Sulphate of	per ton	4	10	0
Lead, Acetate of, white	,,	83	0	0
,, Nitrate of	,,	56	0	0
,, Oxide of, Litharge	,,	45	0	0
,, White	,,	50	0	0
Lime, Acetate, brown	,,	11	0	0
,, ,, grey 80%	,,	17	0	0
Magnesite, Calcined	,,	21	10	0
Magnesium Chloride	,,	16	0	0
,, Sulphate	,,	11	0	0
Methylated Spirit 64° Industrial	per gal.		5	7
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	,,		1	6
,, Carbonate	per ton	95	0	0
,, Chlorate	per lb.		1	0
,, Chloride 80%	per ton	25	0	0
,, Hydrate (Caustic) 90%	,,	160	0	0
,, Nitrate	,,	55	0	0
,, Permanganate	per lb		3	3
,, Prussiate, Yellow	,,		1	9
,, Sulphate, 90%	per ton	30	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	51	0	0
,, Arsenate 45%	,,	60	0	0
,, Bicarbonate	,,	10	0	0
,, Bichromate	per lb.			11
,, Carbonate (Soda Ash)	per ton	12	10	0
,, ,, (Crystals)	,,	4	2	6
,, Chlorate	per lb.			6
,, Hydrate, 76%	per ton	24	0	0
,, Hyposulphite	,,	16	10	0
,, Nitrate, 95%	,,	21	0	0
,, Phosphate	,,	26	0	0
,, Prussiate	per lb.			9
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)	,,	3	0	0
,, ,, (Glauber's Salts)	,,	4	0	0
,, Sulphide	,,	23	0	0
Sulphur, Roll	,,	21	0	0
,, Flowers	,,	21	0	0
Sulphuric Acid, Non-Arsenical 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%	,,	5	0	0
Tartaric Acid	per lb.		3	2
Zinc Chloride	per ton	23	10	0
Zinc Sulphate	,,	22	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Oct. 7 1918 £ s. d.	Oct. 6 1919 £ s. d.
RAND:		
Brakpan	3 16 3	3 11 3
Central Mining (£8)	8 5 0	9 7 6
City & Suburban (£4)	16 3	8 9
City Deep	2 16 3	3 1 3
Consolidated Gold Fields	2 1 0	1 17 6
Consolidated Langlaagte	1 0 3	1 0 0
Consolidated Main Reef	15 0	11 3
Consolidated Mines Selection (10s.)	1 7 0	1 5 9
Crown Mines (10s.)	2 6 3	2 18 9
Daggafontein	1 7 0	1 4 9
Durban Roodepoort Deep	10 0	7 6
East Rand Proprietary	4 9	5 6
Ferreira Deep	15 6	12 0
Geduld	1 17 6	2 17 6
Geldenhuis Deep	13 0	10 0
Gov't Gold Mining Areas	4 12 6	1 15 0
Heriot	17 6	10 0
Johannesburg Consolidated	1 2 9	1 9 6
Jupiter	5 0	4 0
Kleinfontein	16 3	12 0
Knight Central	4 3	5 6
Knights Deep	7 6	8 0
Langlaagte Estate	17 3	16 6
Meyer & Charlton	4 12 6	4 7 6
Modderfontein (£4)	26 12 6	28 5 0
Modderfontein B	8 7 6	8 10 0
Modder Deep (5s.)	7 17 6	2 6 3*
Modder East	—	1 13 9
Nourse	17 0	13 9
Rand Mines (5s.)	3 1 3	3 2 6
Rand Selection Corporation	4 5 0	3 15 0
Randfontein Central	13 0	16 9
Robinson (£5)	16 0	10 0
Robinson Deep A (1s.)	1 3 9	1 1 3
Rose Deep	18 9	16 3
Simmer & Jack	5 0	5 9
Simmer Deep	3 6	2 9
Springs	3 18 9	2 17 6
Sub Nigel	1 15 0	1 5 0
Union Corporation (12s. 6d.)	16 6	1 1 0
Van Ryn	18 0	17 6
Van Ryn Deep	3 13 9	4 1 3
Village Deep	18 9	14 6
Village Main Reef	12 9	10 3
Witwatersrand (Knight's)	1 6 3	18 9
Witwatersrand Deep	9 0	10 0
Wolhuter	5 0	3 9
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	1 3 9	17 6
Sheba (5s.)	1 0	2 0
Transvaal Gold Mining Estates	15 6	17 0
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	16 6 3	24 5 0
Jagersfontein	4 13 9	6 12 6
Premier Deferred (2s. 6d.)	7 12 6	9 10 0
RHODESIA:		
Cam & Motor	11 6	5 6
Chartered British South Africa	18 9	1 1 9
Eldorado	7 0	4 3
Falcon	1 2 6	13 0
Gaika	16 9	17 6
Giant	9 0	8 0
Globe & Phœnix (5s.)	1 10 0	1 0 6
Lonely Reef	1 14 9	2 15 0
Rezende	5 3 9	5 2 6
Shamva	1 17 0	1 15 0
Willoughby's (10s.)	6 6	6 9
WEST AFRICA:		
Abbontiakoon (10s.)	4 6	4 9
Abosso	7 9	14 0
Ashanti (4s.)	1 0 9	1 3 0
Prestea Block A	4 0	6 3
Taquah	15 6	16 6
WEST AUSTRALIA:		
Associated Gold Mines	3 6	3 6
Associated Northern Blocks	3 6	5 0
Bullfinch	1 9	2 6
Golden Horse-Shoe (£5)	2 0 0	1 10 0
Great Boulder Proprietary (2s.)	11 6	11 0
Great Fingall (10s).	3 0	1 9
Ivanhoe (£5)	1 15 0	2 1 3
Kalgurli	9 0	13 0
Lake View & Oroya (10s.)	13 3	1 4 3
Sons of Gwalia	8 0	6 6
South Kalgurli (10s.)	5 6	6 6

GOLD, SILVER, *cont.*	Oct. 7 1918 £ s. d.	Oct 6 1919 £ s. d.
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 9	3 9
Mount Boppy, New South Wales	5 0	9
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	12 0	8 9
Waihi, New Zealand	2 1 0	2 5 0
Waihi Grand Junction, New Z'lnd	16 0	13 6
AMERICA:		
Buena Tierra, Mexico	17 6	18 0
Camp Bird, Colorado	15 6	1 3 3
El Oro, Mexico	15 0	19 6
Esperanza, Mexico	10 0	16 9
Frontino & Bolivia, Colombia	12 6	8 9
Le Roi No. 2 (£5), British Columbia	10 0	11 3
Mexico Mines of El Oro, Mexico	6 0 0	7 7 6
Nechi (Pref. 10s.), Colombia	11 9	12 6
Oroville Dredging, Colombia	1 0 0	1 11 6
Plymouth Consolidated, California	1 5 0	1 6 9
St. John del Rey, Brazil	19 9	18 6
Santa Gertrudis, Mexico	14 3	1 15 6
Tomboy, Colorado	14 6	16 6
RUSSIA:		
Lena Goldfields	1 7 6	1 17 6
Orsk Priority	15 0	13 9
INDIA:		
Balaghat	4 3	4 9
Champion Reef (2s. 6d.)	5 9	4 3
Mysore (10s.)	2 11 3	1 16 3
North Anantapur	7 0	5 6
Nundydroog (10s.)	1 3 6	14 0
Ooregum (10s.)	19 0	14 6
COPPER:		
Arizona Copper (5s.), Arizona	2 6 3	2 0 0
Cape Copper (£2), Cape Province	2 10 0	2 2 6
Esperanza, Spain	8 6	5 9
Hampden Cloncurry, Queensland	1 5 6	19 0
Kyshtim, Russia	2 [illegible] 9	1 7 6
Mason & Barry, Portugal	2 13 9	2 3 9
Messina (5s.), Transvaal	5 0	5 0
Mount Elliott (£5), Queensland	3 5 0	3 15 0
Mount Lyell, Tasmania	1 8 [illegible]	1 4 0
Mount Morgan, Queensland	1 12 9	1 5 0
Mount Oxide, Queensland	7 3	9 0
Namaqua (£2), Cape Province	2 7 6	1 10 0
Rio Tinto (£5), Spain	69 15 0	53 0 0
Sissert, Russia	1 5 6	1 1 3
Spassky, Russia	2 7 6	1 10 0
Tanalyk, Russia	2 7 6	1 12 6
Tanganyika, Congo and Rhodesia	4 15 6	4 11 3
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 5 0	1 6 0
British Broken Hill	2 15 0	2 0 0
Broken Hill Proprietary (8s.)	3 5 0	2 4 3
Broken Hill Block 10 (£10)	1 15 0	1 3 9
Broken Hill North	3 5 0	2 10 0
Broken Hill South	13 10 0	2 2 6*
Sulphide Corporation (15s.)	1 8 3	1 3 0
Zinc Corporation (10s.)	1 8 3	1 0 6
ASIA:		
Burma Corporation	4 9 6	11 8 9
Irtysh Corporation	2 1 3	1 13 9
Russian Mining	1 0 6	17 6
Russo-Asiatic	4 17 6	4 6 3
TIN:		
Aramayo Francke, Bolivia	3 5 0	4 0 0
Bisichi, Nigeria	15 3	13 6
Briseis, Tasmania	5 0	4 6
Dolcoath, Cornwall	10 6	8 9
East Pool, Cornwall	1 9 6	19 6
Ex-Lands Nigeria (2s.), Nigeria	2 9	3 3
Geevor (10s.) Cornwall	1 6 0	1 1 9
Gopeng, Malay	2 3 9	2 1 3
Ipoh Dredging, Malay	18 6	1 1 0
Kamunting, Malaya	1 12 6	2 6 3
Kinta, Malaya	2 6 3	2 15 0
Malayan Tin Dredging, Malay	2 2 6	2 5 0
Mongu (10s.), Nigeria	15 6	1 1 0
Naraguta, Nigeria	18 6	17 0
N. N. Bauchi, Nigeria (10s.)	7 6	8 0
Pahang Consolidated (5s.), Malay.	14 6	15 6
Rayfield, Nigeria	14 3	15 0
Renong Dredging, Siam	2 7 6	2 10 0
Ropp (4s.), Nigeria	1 1 0	1 0 6
Siamese Tin, Siam	3 3 9	3 5 0
South Crofty (5s.), Cornwall	2 1 3	12 6
Tehidy Minerals (15s. pd.) Cornw'l	—	1 2 6
Tekka, Malay	4 5 0	3 5 0
Tekka-Taiping, Malay	3 17 6	6 2 6
Tronoh, Malay	2 3 9	2 7 6

* Share capital expanded.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

HANDLING DUST-ALLAYING WATER IN RAND MINES.

The majority of mines on the Rand have been comparatively dry, and it is only in the near east Rand and in parts of the far east Rand that pumping has been required on an extensive scale. During recent years, however, the drier mines have had to study pumping problems, owing to the large amount of water now employed in keeping down dust. At the August meeting of the South African Institution of Mining Engineers, James Whitehouse gave an account of the method of dealing with this class of water at Village Deep. The water naturally contains an unusually large amount of suspended matter, and the nature of the pumps employed and the means for settlement are the important factors of the problem.

The quantity of water used for allaying dust at Village Deep amounts to 256,000 gallons per day, which is equivalent to 128 gallons per ton of ore hoisted. As it was decided that centrifugal pumps should be installed, some provision for the settlement of the water to be pumped had to be made, in order to prevent the delicate parts of the pumps from being damaged by the solids in suspension. It was decided at the same time to provide sufficient settlement capacity to effect the removal of solids in suspension to such an extent that the clear water could be used for the prevention of dust in rock-drilling. As the position of these sumps is 4,000 ft. below the surface, the advantage of this arrangement will be apparent. As the new settling sumps had of necessity to be situated close to the vertical shaft, they therefore came within the shaft pillar; hence, in fixing their position, and in deciding on their type, the possibility of the utilization of old workings did not enter into the problem. The pump chamber and original sump join the vertical shaft. The new sump and settlers run parallel to the incline shaft and are connected to the old sump by a short cross-cut. In making the excavation, it was decided to fix the floor level at a somewhat higher elevation than the level of the water in the old sump when full. This could be conveniently done owing to the rising grade of the cross-cut and drive from which the work was started. Two considerable advantages are gained by this arrangement, since the water from the new sump can be run into the old one when necessary, and at the same time the clarified water from the settling sumps can be run into either. The water is conveniently introduced into the settling sumps through a cross-cut which was driven from a point sufficiently high at the settling sumps to a point under the main incline. To this point the water from the upper portion of the mine is delivered, together with that which is pumped from the lower workings. There are eight settling sumps arranged in two lines of four, and between the lines there is a passage running the full length of the four sumps. Situated at the delivery end of the settling sumps are two filter beds, between which the passage continues, and beyond these is the main capacity sump. Each of the settling sumps is 28 ft. 6 in. long, 10 ft. 6 in. wide, and 11 ft. 6 in. deep, and has a capacity of 21,800 gallons. Each filter sump is 20 ft. by 10 ft. 6 in. by 11 ft. 6 in., and the capacity sump is 156 ft. by 35 ft. by 12 ft. The excavation for the sumps was carried 32 ft. wide and 6 ft. 6 in. high over the whole length, the floor level being that of the drive from which the work was started. The hanging was afterwards stripped to a height of 16 ft. for the settling sumps and 12 ft. for the capacity area. Finally the central channel which forms the drain through which the sludge is run off was cut in the floor of the chamber. On the completion of the excavation, division walls were built in brick. Each settling sump is provided with a cast-iron door which has an opening 2 ft. square, and also with two smaller 9 in. doors, which were built in the walls for the discharge of the sludge into the central passage. The filters are provided with similar doors, and one was also put in at the end of the passage for discharging from the main capacity sump, should it be necessary at any time to do so. The floors of the settlers have a grade of 10% toward the doors, and the central passage has a grade of 3% to the sludge sump. The floors of the filter beds are graded in concrete as in the settling sumps, and cocoanut matting is laid over a grating and covered with about three feet of clinker.

The water from the upper part of the mine is collected on the level immediately above the settling sumps and there treated with lime. When crude soda was obtainable in large quantities from local deposits, it was used for the purpose of neutralizing the acid in the water flowing to the settling sumps. It was dissolved in tanks on the surface and piped down the vertical shaft to the sumps. When it became impossible to obtain this product, lime was used for the purpose, but it was found that this could not be sent from the surface in pipes owing to their choking up after being a short time in use. It was therefore decided to feed the lime into the water mechanically underground, and this is conveniently done by means of a feeder designed by Mr. Gray, of the Crown Mines. This feeder is driven by a small motor, and the design is such that a consistent feed is assured. The neutralization obtained by this method reduces the acidity to about 0·002, so that, after settlement, the water can be pumped without any damage to the pumping plant.

The operation of the sumps is as follows: From the cross-cut leading from the incline shaft the neutralized water from the upper levels, mixed with the water pumped from the lower levels, is laundered to the distributing box, and from here it is delivered into the settling sumps, each sump having two delivery launders leading from the main launder, which runs the whole length of the settlers. The two streams of water going to each sump are delivered through box launders below the surface of the water to a depth of 7 ft. 6 in., and, in order to prevent currents being set up, the two down-launders are connected by a perforated horizontal launder, which distributes the flow in all directions. The outflow water is drawn off through V-lip launders into a common launder, which again runs the entire length of the settlers. At the filter-bed end of the sumps this water can be distributed as desired, the proportion required for the mine water service being diverted to the filter beds, the surplus being turned into either capacity sump. Should the proportion turned into the filter beds be too large, the excess overflows into the capacity sump. The water which enters the filter beds is further clarified by passing through the clinker, and is drawn off from under the cocoanut matting to supply the mine. As it enters the filter bed it is treated with a solution of soda, which neutralizes any acidity present, and so protects the pipes through which it is distributed to the workings. Working under the conditions as described, the consumption of lime and soda per day is 2,400 lb. and 300 lb. respectively, costing £4. 15s., which is equal to 1·96 pence per 1,000 gallons treated.

When sufficient mud has been collected in any settling sump, the inflow is stopped and the water is allowed to finally settle. The water is then drawn off through a pipe which passes through the wall at a depth of 7 ft. below the surface of the water by a small centrifugal pump at the entrance to the settlers, and delivered into the distributing box once more. The mud is released by opening the mud-doors, and flows by the central passage into the sludge sump. From here it gravitates through pipes down the sludge winze into the filter-presses on the level below, or it can be piped direct into the skips and pulled to the surface. The time taken to clear a settling sump from stopping the flow to restarting is two hours.

It has been found convenient to discharge all the sumps at a week end, one after the other, and the time taken to clear them all and hoist the mud to the surface is 6½ hours. This is usually done once a fortnight, and about 155 skip-loads of sludge are hoisted. During this period about 8,189,000 gallons of water are passed through the sumps, and the above represents the amount extracted from this quantity of water. The average percentage of solids by weight settled out of the inflowing water amounts to 0·4372 per cent, or one pound of solid matter for 22·9 gallons of water passing through the sumps. There are no large feeders of clean water emptying into the mine, and hence the percentage of solids is greater than it would be in a mine where large volumes of water are derived from this source.

Apart from its efficiency as a settler, the type of sump described above has certain advantages to which attention might be drawn. The excavation is rapid, a point often of considerable importance, because the removal of the ground broken is effected by means of tracks carried on an even grade from the level into the sump, a method both easy and inexpensive, and comparing very favourably with that of hoisting the broken ground out of an excavation below the drive level. The water used in drilling finds its own way out into the drive, and no water from the drive can enter the excavation, so that all water troubles are eliminated. Again, should there be a large increase in the water to be settled, or a rush of sand from sand-filling, one unit can be cut out as often as desired, and the mud removed from it while the remaining sumps continue in operation. The settlers as a whole need never become full or get into such a condition that the mud cannot be removed when desired. In discharging mud only one-eighth of the settling capacity is cut out, and then only for two hours. Further, the water to be pumped is above the level of the pumps and gravitates to them.

MAGNESITE IN WEST AUSTRALIA.

The West Australian Geological Survey has issued a report by F. R. Feldtmann on the magnesite deposits at Bulong, about 20 miles due east of Kalgoorlie. The deposits have been known since 1897, and in 1914 trial shipments were made. They have been worked to a limited extent by the Magnesia Syndicate and its successor, the Permasite Manufacturing Co.

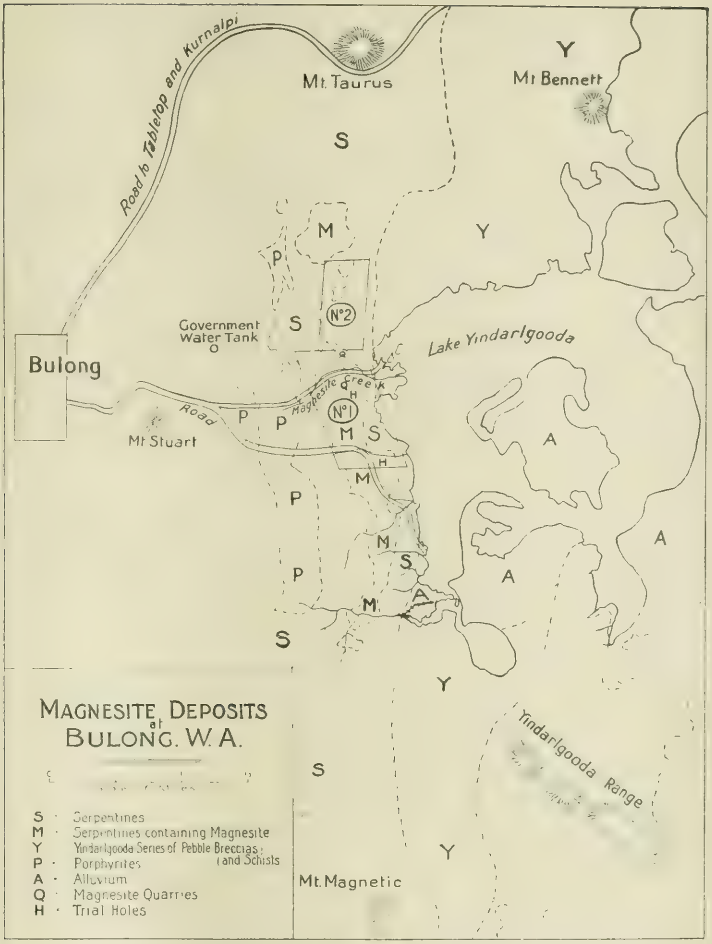
Bulong is on the west side of Lake Yindarlgooda and lies in a complex of basic and ultrabasic greenstones, the most prominent members of which are serpentines and amphibolized gabbros. In the gold-mining area west of the town, many of the rocks are talcose and highly carbonated. The greenstones extend eastward to the western edge of the lake, and northward beyond Mt. Taurus. The various members of the complex are intimately associated, and, as at Kalgoorlie, to the younger greenstones of which they correspond, apparently represent local differentiations of a highly basic magma, intruded as one mass. The eastern part of the complex is more highly basic than that west of Bulong and, except for a few small areas of gabbro or amphibolized gabbro, consists wholly of serpentine, with which the magnesite is invariably associated. Intruding the greenstones west of the magnesite areas are several large porphyrite dykes—the largest being a mile in length—striking north and south. A few small dykes are found in and near the main magnesite area. Porphyrite dykes, apparently of considerable length, also occur west of the town, intimately associated with gold lodes. A number of small porphyrite dykes, almost black in colour, striking east and west, intrude the greenstones close to the magnesite areas. These dykes may belong to a different period of intrusion, but more probably formed part of the same magma as the other dykes and were intruded along lines of weakness complementary to the main lines.

East of the main greenstone area is a belt of highly sheared rocks of clastic origin, containing numerous ellipsoidal pebbles of porphyrite—but, so far as could be determined, of no other rock—as well as smaller angular and sub-angular fragments of the same rock. These rocks are best described as pebble breccias. The planes of shearing strike north and south, and dip west at steep but varying angles. The extreme western edge of the lake approximates to the boundary between these rocks and the greenstones. North of the lake, rocks forming part of the same series extend eastward beyond Mt. Tabletop, on the road to Kurnalpi. Immediately south of the westernmost part of the lake, the pebble breccia belt—here probably only a branch of the main belt, which is some miles farther east—is a little more than a mile wide. Two and a half miles farther south it is only three-eighths of a mile wide.

Another area of highly schistose rocks, probably belonging to the same series, underlies the alluvial flat south of the Government Tank. The few exposures of these rocks are too weathered for accurate determination. No pebbles were seen in the rocks, some of which are of slaty appearance; others appeared to resemble the matrix of the pebble breccias. Part of the western boundary of these schists can be mapped with some degree of accuracy, but the eastern boundary is entirely obscured and the full extent of the area occupied by them cannot be ascertained with any certainty.

In the greenstones north and north-west of the town are several comparatively small areas of apparently clastic rocks, some of which resemble the pebble breccias, but contain no pebbles; others the slaty rocks previously mentioned. These smaller areas possibly represent portions of the main belt which have been nipped in during periods of compression.

East of the pebble breccias south of the lake, and



forming the Yindarlgooda range of hills, is a second area of greenstones. These are, on the whole, less highly basic than the rocks of the magnesite area and appear to consist of amphibolized gabbro and comparatively fine-grained epidiorite. They extend to the western edge of the lake, east of the Yindarlgooda range. They have been intruded by many small dykes of porphyry or porphyrite, the direction of strike of which is variable, but predominantly ENE. In composition these dykes appear to be somewhat more acid than those intruding the main greenstone area.

The largest area of magnesite-bearing serpentine occupies a basin elongated in a nearly north and south direction, parallel to the lake edge, the northern end of the basin being nearly 2¼ miles due east of Bulong. The basin lies between a high, steep ridge rather more than half a mile west of the lake, and a lower and more broken series of hills fringing the lake and connected with the main ridge north and south of the basin. The magnesite area extends for about ¾ mile south of the basin, its total length being nearly 2¼ miles. It is irregular in width, ranging from about 30 chains at its northern end to about 5 chains near its southern end, averaging about 18 chains. It covers about 350 acres. The southern half of this area is largely obscured by superficial deposits. Several smaller areas of magnesite-bearing rock occur, one south and three north of the main area, the northernmost, about ¾ mile north of the main deposit, being the largest. It occupies a basin about half a mile long and more than 30 chains wide at its widest point, and covers an area of about 90 acres. No magnesite deposits were seen south of those mentioned, other than occasional small boulders, nor is it likely that deposits of any size occur. A few small patches, negligible from an economic point of view, were observed to the north of those mapped, and it is possible that others occur in the vicinity of Taurus. Small lenses of magnesite were seen in two places in the pebble breccias near the boundary of the serpentine; the magnesite here has evidently been dissolved out of the serpentine by surface waters and redeposited in the clastic rock.

The ridge west of the main magnesite area rises to a height of about 240 ft. above the level of the lake. It forms the southerly extension of a wide and irregular hilly area, scored by deep valleys, which stretches northward to the west of the Taurus group of leases. The ridge runs south for a considerable distance. Opposite the southern end of the basin, three miles south-east of the town, it widens out to a complex of hills; farther south it gradually becomes less defined but rises abruptly at Mt. Magnetic, about five miles south-east of Bulong, to die out a little farther south.

The hilly area north of the ridge is joined about one and a half miles north of the Government Tank by an escarpment running in a south-south-west direction, about ½ mile east of the town. This escarpment faces east-south-east and the flat below it gradually falls toward the lake. South of the Government Tank the flat is about 130 ft. below the surface level at the Post Office, and about 60 ft. above the level of the lake. It is drained by a series of watercourses mostly ill-defined which, toward the eastern end of the flat, unite to form a deeply cut creek known as Magnesite Creek. The creek runs east to the lake, cutting through the previously mentioned ridge. West of the ridge a second creek runs into the first one from the north.

The road from Bulong to the magnesite quarries crosses the escarpment west of Mt. Stuart, thence passes to the north of the mount and runs eastward over the flat to follow Magnesite Creek through the gap in the main ridge to the quarries; thence the road runs on to the old battery site. This road is good, on the whole, though heavy on the flat in wet weather.

The magnesite occurs, for the most part, as short irregular veins in the serpentine. In places these veins are so numerous as to form a stockwork. Being less subject to weathering than the surrounding rock, and of a dazzling white colour, except where stained by iron, they stand out conspicuously above the surface of the ground. The veins are very irregular both in strike and dip. Some of the larger veins strike about N15°W, and, where exposed, dip fairly steeply west-south-west; others are almost flat, but most of the veins are greatly contorted. Where a number occur together they are usually roughly parallel. None of the veins approach those of the Grecian and Californian deposits in size, rarely attaining a width of two feet. Most are only a few inches in width, and a number are mere threads. Where the serpentine is much decomposed, as at the main workings, the veins are exceedingly numerous, in places occupying a greater volume than the enclosing material. In such places the enclosing rock is soft, enabling the veins to be quarried easily.

In a few places the magnesite forms a surface deposit. The largest deposit of this type covers a large portion of an area of about 15 acres, immediately south of Magnesite Creek. The two larger quarries are on the northern edge of this deposit, which in a few places is over a foot thick. It is probably due, in the first place, to the occurrence of large flat veins of magnesite, the intervening country being covered by material resulting from the degradation of the vein outcrops, which has been recemented through the agency of surface waters. These surface deposits are usually more discoloured than the veins.

As shown by the analyses, the proportion of impurities present in the magnesite varies considerably. The specimen collected by the writer from No. 2 quarry appeared to be fairly representative of the larger veins. The exact localities of the other specimens analysed have not been ascertained, but it is most probable that they were obtained from the surface deposit near No. 2 quarry. A few of the veins at the southern end of the main area are of a creamy colour; in others small vughs, thinly lined with chalcedonic silica, are present. On the small hills south of the basin the magnesite at the surface contains much opal. The specimens analysed were comparatively free from lime, and though a fair amount of silica is shown in two of the analyses (one specimen contained small vughs lined with chalcedony), the quantity present in the larger veins probably averages much less. The quantity of iron and alumina present is not great, but it has been found that there is sufficient iron present—some in the form of ferrous carbonate—to discolour the calcined material. The magnesite can, on the whole, however, be regarded as fairly high grade. The purer material can be largely separated by hand-picking

ANALYSES OF BULONG MAGNESITE.

	1 No. 2 Quarry	2	3
Magnesia, MgO	47·36	44·96	44·31
Carbon dioxide, CO_2	51·69	49·33	47·76
Combined water, H_2O+	—	0·08	*Nil*
Moisture, H_2O −	0·15	0·97	1·17
Silica, SiO_2	0·12	1·12	4·99*
Alumina, Al_2O_3 / Ferric oxide, Fe_2O_3	0·16	0·56	0·42
Ferrous oxide, FeO	—	—	—
Lime, CaO	*Nil*	1·06	*Nil*
Sodium chloride, NaCl	0·53	1·76	1·39
Potassium chloride, KCl	0·01	0·09	0·08
Magnesium chloride, $MgCl_2$	0·08	*Nil*	0·11
Sulphur trioxide, SO_3	trace	0·13	0·15
Total	100·10	100·06	100·38

* The specimen contained small vughs lined with chalcedonic silica.

Two mineral claims, of 300 and 150 acres respectively, are held by the the Permasite Manufacturing Company, Limited. One covers the northern half of the largest magnesite area, and includes the best of the deposits, while the other includes two small areas north of the main area. The second largest deposit, which is not so accessible as the main area, lies immediately north of the second claim, and is not covered by any claim. The magnesite in this deposit is largely obscured by detrital material, and the writer was unable to form an estimate as to the relative proportion of veins therein.

The magnesite mined up to the present has been obtained from three quarries in No. 1 Claim. No. 1 quarry, 300 ft. north of Magnesite Creek and a little east of a large watercourse which runs into the creek from the north, was, at the time of the writer's second visit, over 40 ft. in length by about 25 ft. in width; it ranged from 10 to 15 ft. in depth. The rock in this quarry, though containing a fair number of magnesite veins, was not so thickly veined as that in No. 3 quarry.

The other two quarries are from about 80 to 220 ft. south of the creek, No. 3, the largest, being about 1,000 ft. south-west of the north-east corner of the claim. This quarry was 140 ft. long, by an average width of 26 ft., and was 20 ft. deep at the southern end, where the magnesite veins appeared to occupy more than half the total area of the rock. No. 2 quarry, about 90 ft. west of No. 3, was about 55 ft. long by 15 ft. wide, on the average, and was 12 ft. deep at the southern end.

In addition, a number of trial holes have been sunk, to depths of about 6 to 7 ft. Veins of magnesite were cut in each, but were more numerous and, on the whole, larger in the northern group of holes.

The deposits were not being regularly worked during the writer's second visit, but parcels were being sent away from time to time, as required. According to the estimate of the company's manager at Bulong, the magnesite "at grass" at the time of the second visit was as follows: 7 tons of "firsts" bagged and ready for carting, 496 tons of "firsts" broken and stacked at quarries, and 70 tons of "seconds" broken and stacked at quarries. A total of 688½ tons of magnesite was quarried and exported in 1915, and 10½ tons in 1916. In 1917, 73 tons left Bulong, of which about 20 tons was treated in Western Australia. The value of the mineral is estimated at £1 per ton on the ground, the export value being estimated at a trifle under £4 per ton.

WORKING CONDITIONS IN HOT AND DEEP MINES.

A committee was appointed some time ago by the Department of Scientific and Industrial Research, on the nomination of the Institution of Mining Engineers, to investigate the effects of depth, heat, and the quality of the air on workers in mines, and to suggest means by which improvements in the conditions may be obtained. A preliminary report was submitted at the meeting of the Institution of Mining Engineers held at Birmingham last month, indicating the lines of investigation and the detailed points on which information is being collected. We give herewith a summary of this report.

Although the body-temperature is extremely steady at about 98° to 99°F., and any abnormality in it causes symptoms of illness, it is well known that men can live in perfect health at air-temperatures varying from considerably below zero to 120° or more.

The worker is able to regulate his condition as regards clothing and muscular exertion, so that as long as he is in a position to take suitable measures, he is in little danger of harm from cold or heat. In metalliferous mines work is often carried on in places where the air is so warm and moist that continuous work would be quite impossible. The men simply work for only short periods, and come out as soon as they begin to feel uncomfortable. In this way the work is carried on without the smallest risk to safety or health, but is, of course, very expensive on account of loss of time. In air where the heat is not so great as to prevent continuous work, it may, nevertheless, be impossible for men to work at their ordinary rate without abnormal rise of body-temperature, so that the work they actually do is below the limit of economic productiveness. It is this fact, and not any question of health or safety, with which the present inquiry is concerned. Work which is economically unproductive is just as much excluded in mining operations as work which endangers safety or health.

The body regulates its internal temperature by several means. The first of these is by regulating the blood-flow through the skin. If the temperature of the air is below that of the body, heat is withdrawn from the body by both conduction (including convection) and radiation. The loss by conduction to air tends to vary with the rate of movement and temperature of the air, while the loss by radiation tends to vary with the surrounding temperature. By varying the rate at which blood is circulating through the skin, the body regulates this loss of heat, as in proportion to the cooling of the skin a smaller quantity of cooled blood passes inwards from it, and *vice versa*. It is evident, however, that this means of regulation must fail in a sufficiently warm atmosphere.

A further means of regulation depends on the fact that in a cold environment the production of heat within the body tends to be increased by increased muscular activity. But there is a limit to the amount by which the heat production in the body can be diminished. Hence this means of regulation must also fail in a sufficiently warm atmosphere.

In warm atmospheres there is a third means of regulation, and this is the most important one in relation to deep and hot mines. As soon as the body-temperature tends to rise above normal, there is active secretion of sweat by the skin, and the disappearance of heat in the evaporation of this sweat keeps the skin cool; so that even when the air-temperature is far above the body-temperature, the latter remains normal if the sweat can evaporate with sufficient freedom.

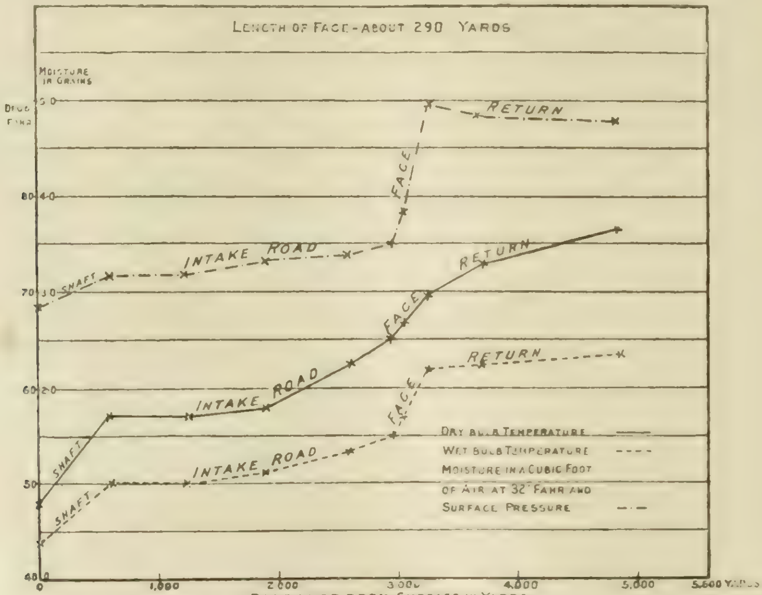
So far as mining conditions are concerned, the capacity of the body for sweating to the requisite extent is practically unlimited; but the conditions for evaporation of sweat may be altogether defective. Consequently, everything turns on these conditions. It is clear that if the air were already saturated with moisture at the body-temperature, there could be no evaporation from the skin, so that no heat could be given off. The body would then be defenceless against heat, and despite profuse sweating the body-temperature would drift upward. If, however, the air were only saturated to a lower temperature—that is to say, if the dew-point were at a lower temperature—evaporation from the skin could still occur; and if both the evaporation and the skin circulation were fast enough, the body could get rid of its superfluous heat. Now the rate of evaporation is practically proportional to the rate at which air passes over the moist skin or clothes. If this air were completely stagnant, the aqueous vapour could only escape outward by the extremely slow process of gaseous diffusion. On the other hand, unsaturated air not only tends to cool down a moist surface toward the dew-point, but also tends by conduction to warm up the cooled surface toward the air-temperature; and unless the air-current is very considerable, radiation will also contribute appreciably in this direction. The result is that when there is a sufficient air-current to swamp the influence of radiation and conduction through still air, the surface assumes a definite temperature between the air-temperature and the dew-point; and when no other source of heat or cold is affecting the surface, this intermediate temperature is known as the wet-bulb temperature, as it is the temperature assumed by the bulb of a thermometer kept moist with water. The temperature of the moist skin is evidently not the wet-bulb temperature, but something intermediate between the latter and the body-temperature, since the body-heat is tending to warm the skin. The greater the air-current, however, the more nearly will the skin-temperature approximate to the wet-bulb temperature if the skin is moist, provided that the heat-flow from the interior of the body to the skin remains constant.

As the wet-bulb temperature is the temperature to which a moist surface can be cooled by evaporation in air if the cooling is not hindered, and the wet-bulb temperature may be the same when the air-temperature and dew-point are far apart, it is only to be expected that, other things being equal, such as the amount of clothing, the air-current, and the production of heat in the body, the effect of warm air in raising the body-temperature abnormally will depend on the wet-bulb temperature. That this is actually the case was shown by Haldane, who found by observations in a hot disused level at Dolcoath mine and in laboratory experiments that if the wet-bulb temperature exceeded 88° in perfectly still air, and during rest, with a minimum of clothing, the body-temperature rose continuously, and the faster the higher the wet-bulb temperature. What the air-temperature, or the dew-point, or the relative humidity were, did not matter except in so far as they affected the wet-bulb temperature. Thus an air-temperature of 133°, with the wet-bulb at 88°, had no more effect on the body-temperature than an air-temperature of 88° with the air saturated. At both temperatures the body was just able to keep its temperature from rising, and there was profuse sweating; but at 88° most of the sweat failed to evaporate, and was thus wasted. In a further series of experiments at the Doncaster Coal Owners' Laboratory and at Oxford, Haldane found that when the wet-bulb temperature was above the body-temperature, the rate of rise of body-temperature depended also (other things being equal) on the wet-bulb temperature and not on the air-temperature. When an air-current was present, and the wet-bulb temperature was below the body-temperature, it required a higher wet-bulb temperature to cause a rise of body-temperature, just as might be expected. But with the wet-bulb above the body-temperature, an air-current accelerated the rise of body-temperature; and with the wet-bulb temperature at 120° or more, a painful burning sensation was produced by moving air or by bodily movements which brought more air into contact with the skin. When muscular work was done, the wet-bulb temperature at which the body-temperature began to rise was lower, as could be expected in view of the greatly increased heat liberated in the body during work. In other words, continuous hard work was impossible in still air unless the wet-bulb temperature was considerably below 88°. Thus, even with the wet-bulb temperature at 78°, continuous fairly hard work in still air was impossible. The wet-bulb temperature at which, with an air-current such as might be expected along a well-ventilated working face, and an amount of work such as an average miner does, the normal body-temperature could be maintained was not determined, and remains to be ascertained. Judging, however, from such observations as have yet been made in deep and hot mines, this wet-bulb temperature is not much above 80°, and for the purposes of the present report 80° may provisionally be assumed.

In this country the outside wet-bulb shade temperature, in even the hottest summer weather, is seldom above 70°, and then only during the hottest part of hot summer days. A wet-bulb shade temperature over 73° is scarcely ever experienced, and such a temperature is exceedingly trying to persons wearing ordinary clothing. In a mine, however, clothing is reduced or discarded as the wet-bulb temperature rises, so that men may be quite comfortable at wet-bulb temperatures of 80° or more. In some tropical countries the shade wet-bulb temperature is often over 80° for several days at a time; but in dry tropical heat the wet-bulb temperature is often below 70°, although the shade temperature is 110° or more.

It seems evident from the foregoing considerations that in dealing with the difficulties caused by heat in deep mines the chief aim of mining engineers must be to keep down, not the air-temperature itself, but the wet-bulb temperature; and a subsidiary aim is to keep the air in motion as far as possible at all working places.

With increasing depth, the natural temperature of the strata increases steadily; and a common rate of increase appears to be about 1 degree in 70 ft. Thus, assuming that the mean surface temperature in this country is about 49°F., the natural rock-temperature at 2,200 ft. will be about 80°. If, therefore, there was very little ventilation, the air-temperature would not be less than 80°, and the air would be saturated with the moisture given off from the damp strata. Actually, however, the air would be saturated at over 80°, as oxidation of coal, timber, etc., would raise the temperature. There would, therefore, be very serious difficulty from the heat. If, however, the ventilation were adequate, the conditions would be very different. The difference is illustrated by a set of observations from a series carried out for the Committee by Messrs. Graham, Storrow, and Rees at Brodsworth and Bentley Collieries, near Doncaster. In the accompanying chart in the text the results are plotted of observation of air-temperature and wet-bulb temperature along the course of an air-current supplying a section of longwall face at Bentley Colliery. The current was ample, with a view, not to coolness, but of diluting the firedamp given off by the seam. The data illustrate well, however, the effects of good ventilation on the air-temperature, wet-bulb temperature, and taking up of moisture by the air. Considering first the air temperature, it appears that in the descent of the shaft there was a rise of 9°. As the depth was 1,875 feet, and as for every 1,000 ft. of descent the air-temperature rises nearly 5½°, owing to compression of the air, if no heat is lost or gained from other causes, this rise of temperature is rather less than would be accounted for by compression.



On an average for the year, a little heat will be gained from the strata owing to conduction through the shaft-walls, and some will be lost owing to evaporation of moisture from the surface of the shaft-walls. In the Bentley shaft the loss of heat by evaporation predominates, and an average of a large number of observations has given a difference of only 8·2° between the top and the bottom of the shaft, with evaporation in the shaft of 0·27 grain of moisture per cubic foot of air. On cold days the difference of temperature between the top and the bottom is much more than 8·2°, and on warm days much less, as the shaft-walls give off heat to the colder air, and absorb it from the warmer air. On an average, however, the temperature of the shaft-walls is practically determined by the average temperature of the air passing down (as modified by compression in one direction and by evaporation in the other), and not by the natural temperature of the rock. This is due to the fact that there is a very extensive layer of cooled rock round the shaft, so that heat from the rock beyond this layer is very slow in penetrating through to the air. Calculation shows that its effect in warming the large volume of air passing down is inappreciable. Heating by compression would account for a mean rise of 10·2°, and cooling by evaporation for a fall of 2·0°. The actual rise of 8·2° is thus accounted for, apart from conduction of heat from the strata. In the first 1,300 yards of intake road the temperature, as shown by the chart, rises only 1°, but thereafter, owing to the much smaller air-current in consequence of splitting, the rise of temperature is faster, and continues until the air on its return path is within about 1,000 yards of the upcast shaft. The rise is rapid as the air passes along the freshly-exposed and therefore warm mineral at the face (including gates), and would be much more so but for the cooling effect of the extensive evaporation of water and methane. At the far end of the face the air-temperature is still about 5·5° below the natural rock-temperature, which is about 75°; and despite a slight amount of heating due to oxidation, the air-temperature does not rise to the natural rock-temperature till the air has returned a long way towards the upcast shaft. Looking back on the temperature data, it is seen that practically speaking the mean air-temperature in the shaft and main intakes is not influenced at all by the natural rock-temperature.

It will be seen that the wet-bulb temperature rises 6° as the air descends the shaft. This rise is due partly to the warming of the air by compression (less the fall due to evaporation); partly to its diminution in volume, so that more moisture is contained in unit volume; and partly, as will be seen from the upper curve in the diagram, to the small amount of evaporation from the shaft-walls. Conduction of heat from the strata contributes nothing to the rise. As the air passes along the intake the wet-bulb temperature rises slowly, its rise lagging more and more behind that of the air-temperature, so that when the air reaches the face the wet-bulb is 10° below the dry-bulb and 20° below the rock-temperature. As the air passes along the face the wet bulb rises 7° owing to further warming of the air, and the rapid evaporation of moisture from the warm and freshly-exposed coal. In the returns, which are already dry, there is hardly any further rise of the wet-bulb temperature, despite the rise in the air-temperature; and finally the wet-bulb is 13° below the dry-bulb and 11° below the natural rock-temperature. At no point is the wet-bulb so high as to cause the slightest inconvenience to the men.

The curve showing the moisture in the air is calculated for the moisture contained not in 1 cubic foot of air at the existing temperature and pressure, but in 1 cubic foot reduced to normal barometric pressure and freezing-point, in other words, for the moisture in a given mass of air. Thus the chart gives an approximately true picture of the amount of moisture which air takes up as it passes through the mine. It will be seen that in the 3,000 yards from the surface to the working-face the air takes up only 0·7 grain of moisture per cubic foot, while in 290 yards of face it takes up 1·5 grains, or at a rate twenty times as great per yard of travel. This is a striking fact, of fundamental significance in relation to the problem. The rapid evaporation of moisture along the face is, of course, due to the fact that the freshly-exposed mineral is moist; whereas along the roads the mineral, etc., has already lost to the air nearly all the moisture it can give off. In this connection it must be borne in mind that coal, shale, etc., are hygroscopic, and thus always capable of either absorbing moisture or giving it up to the air. If the air becomes, owing to varying conditions on the surface, either moister or less moist, it will take up or give off moisture correspondingly, and it will thus tend to keep the hygroscopic conditions of the air steady. The slight diminution of moisture in the return air is doubtless due to slight leakage direct into the return from a cross gate.

The chart throws a flood of light on the problem. In the first place, it is evident that if the shaft and roads are dry, air containing very little more moisture than the outside air, and at a temperature much below the natural rock-temperature, can be brought right up to the working-face, with the consequence that the wet-bulb temperature in this air is very low, and its cooling capacity correspondingly high. The rise in temperature of the intake air during its passage of 2,400 yards from the pit-bottom to the working-face is a little less than half the difference in temperature between the air at the pit-bottom and virgin strata. As there is no appreciable oxidation along the intake roads at Bentley, this rise is due to conduction of heat from the strata. From the extent of the rise it can be inferred with great probability that if the depth had been 4,000 ft., with a probable mean temperature of about 66° at the pit-bottom, and a rock-temperature of 106°, the temperature at the in-bye end of the intake would have been about 83° and the wet-bulb temperature about 63°, a very comfortable condition, and leaving a large margin of admissible rise of air-temperature and wet-bulb temperature along the face, without any diminution of working power.

It must, however, be also considered what would be likely to happen if both shaft and intake roads were wet. In this case the air and wet-bulb temperatures would certainly remain close together, but, provided that the air-current were sufficient, the air-temperature would be much lower on account of the cooling influence of evaporation. The wet-bulb temperature would thus probably be only very slightly higher, and the lower temperature would nearly balance the effect of the higher proportion of moisture, so that the potential cooling power of the air would be nearly the same. This, however, would be the case only in the downcast shaft and main roads. At parts beyond, the wet-bulb temperature would certainly rise higher, with corresponding disadvantage to working capacity. So far as possible, therefore, it seems better to keep the shaft and roads dry, and to deal with coal-dust by stone-dusting rather than by watering. Timber, also, is more easily preserved in the dry air, and the risk of ankylostomiasis infection is eliminated.

What would happen if the ventilation were greatly decreased, or if, owing to leakage from intakes to returns, the quantity of air reaching the face were greatly diminished? Owing to the slower air-current, the constant leakage of heat from the surrounding strata into the intake road would have a much greater effect in raising the air-temperature, so that for this reason alone the temperature of the air would be nearly that of the strata by the time the air reached the face. Similarly, the leakage of moisture into the road would tell more heavily, so that the air would be nearly saturated at the temperature of the strata. Oxidation of timber in the damp air, and of any coal round the road, would also raise the temperature to a far greater extent. How serious the rise of temperature from oxidation may be in certain circumstances was clearly shown by Haldane and Meachem, in a paper read before the Institution of Mining Engineers in 1898. These authors found that the temperature, not only in working-places and returns, but also in intakes, might be considerably above the natural temperature of the strata. Thus on one branch intake, about 3,000 yards from the shaft, they found the temperature 16 above the rock-temperature, with a deficiency of 0 88% in the oxygen. Other striking instances of this, particularly in metalliferous mines, have also been recorded. It must further be taken into account that the diminished movement of air would increase the effect of the heat on the men. It is thus easy to see that with insufficient ventilation the problem of keeping the wet-bulb temperature sufficiently low to render ordinary work economically possible would always be serious at depths of over, say, 2,000 ft., and would frequently be serious at less depths, especially where much leakage from intakes to returns existed. On the other hand, with adequate and properly-planned ventilation, there would seem to be no reason to doubt that in this country at least, or in any fairly dry or fairly cool climate, the wet-bulb temperature can, by ventilation alone, be sufficiently controlled to make work economically possible at any depth at present in contemplation and up to at least 5,000 ft.

Thus the problem of underground temperature control seems to resolve itself into that of adequate ventilation, planned with a clear conception of what is required in order to prevent loss of the miners' working capacity, and not merely to obviate trouble from firedamp or vitiation of the air by other gases.

The conclusions reached in the present report may be summarized as follows:

(1) The hindering effects on men of the heat in deep mines depend, not on the temperature of the air, but on the wet-bulb temperature and the degree of stagnation of the air.

(2) In the downcast-shaft and main intakes of a well-ventilated coal-mine the natural temperature of the strata has no appreciable influence either on the temperature of the air or on the wet-bulb temperature.

(3) The data as yet available indicate that by properly-designed ventilation and avoidance of leakage the hindering effects on men of the heat in deep mines can be obviated up to any depths at present contemplated in the working of coal or other minerals in the British Isles.

Ventilation at St. John del Rey.—In the discussion of the report of the committee on working conditions in hot and deep mines, which was presented at the meeting of the Institution of Mining Engineers held at Birmingham last month, Eric Davis gave some particulars of the problem at the Morro Velho gold mine of the St. John del Rey Co., in Brazil. As is well known, this mine is the deepest in the world, the lowest working being 6,400 ft. vertically below the surface, and 3,650 ft. below sea level. Luckily the rate of increase of rock-temperature with depth is considerably less than that indicated in the report as being usual. Whereas the report gave 1°F. for every 70 ft., at Morro Velho it is only 1° for every 140 ft., although there are indications that the rate is increasing slowly for increased depth, so that for the lowest 2,100 ft. the rate has been about 1° for every 119 ft. In the year 1913 Mr. Davis was entrusted by Mr. George Chalmers, the superintendent of the mine, with an investigation into this matter with a view to overcoming the difficulties and rendering the mine workable at depths considerably greater than those which had been reached. The only instruments he had were an aneroid barometer and wet-bulb and dry-bulb thermometers. Readings were taken at every level right down through the mine, and the results were plotted on diagrams having depth in feet for base. It was found that the dry-bulb temperature at any one point in the mine remains practically constant all the year round, but that the wet-bulb temperature undergoes considerable variations. For the same dry-bulb temperature and barometric pressure the wet-bulb temperature depends on the moisture content, and the tests he took showed that—the conditions being equal, and the mine being a dry one—the moisture content at any point underground, and therefore the wet-bulb temperature at that point, depends almost entirely on the moisture content of the surface air entering the downcast shaft. The whole question therefore boiled down to finding by analogy from the diagrams that volume of the entrance moisture contents which would give wet-bulb temperatures in the working zone below what had been fixed upon as the limiting value, corresponding to the 80°F. mentioned in the report. Then the temperature at which the air when saturated with moisture would have this required initial moisture content was that to which the downcast air would have to be reduced before it entered the mine. By hourly hygrometric observation at the surface, extending over a whole year, the worst conditions likely to be reached by the surface air became approximately known. Hence, knowing the volume to be dealt with, the amount of refrigeration necessary, power required, and so on, could be calculated. It was found from the diagram that in order that the wet-bulb temperature in the stopes should not exceed 82°, which they had fixed upon as the maximum desirable, the initial moisture content must not be more than about 50 grains per pound of dry air, corresponding to a saturated condition at 45 5°F. The plant, which was now being erected, and which was mainly manufactured by Messrs. J. & E. Hall, Limited, of Dartford, was capable of eliminating about 100,000 B.T.U. per minute. This corresponded to the cooling of the volume of air, 80,000 cu. ft. per minute, from an initial wet-bulb temperature of 72° (slightly below the maximum actual condition) to 43 5°, so that it was on the safe side. As the surface wet-bulb temperatures varied during the year between 75° and freezing point, 32°, it is obvious that the refrigerating load on the plant would be a very variable one. To meet these conditions they were dividing the plant into six stages, each complete with its own motor-driven ammonia compressor, condenser, and evaporator. The number of those sets running at one time would of course depend on the initial temperature conditions. The air-cooling would be accomplished indirectly, as it would be deadly to have ammonia mixed with the entering air. Therefore the ammonia would be used to cool water which in its turn would cool the air as it passed through by Heenan air coolers. The whole plant is on the surface, and deals with the downcast air before it enters the mine at all. The mine is absolutely dry, and therefore there is no fear of any great amount of moisture being picked up by the air in its course. The plant now being installed will cost about £50,000, and the power required is about 500 h.p. Provision is made for the addition to the original six stages of three further stages in case they should go deeper and still further cooling be required. The ventilation is effected by means of exhaust fans.

Geological Problems.—In his address before the Geological Section of the British Association, Dr. J. W. Evans spoke of many lines of research open to the economic geologist. We quote some of his remarks herewith.

It is difficult to arrive at the true interpretation of the phenomena presented by the rocks which have come into existence by the action of the forces on the earth's interior, for the conditions of temperature and pressure under which they were formed, whether they are igneous rocks in the narrower sense, or mineral veins, or metamorphic in origin, were widely different from those with which we are familiar. Under such circumstances the ultimate physical principles are the same, but the so-called constants have to be determined afresh, and a new chemistry must be worked out. It is necessary, therefore, as far as possible, to reproduce the conditions that prevailed, a task which has been courageously undertaken and to a considerable extent accomplished by the Geophysical Laboratory of the Carnegie Institute at Washington. By artificial means temperatures and pressures have been already produced far higher than those that were in all probability concerned in the evolution of any of the rocks that have been revealed to us at the surface by earth-movements and denudation, for it is unlikely that in any case they were formed at a greater depth than five or six miles, corresponding to a uniform (or, as it is sometimes termed, hydrostatic) pressure of 2,000 or 2,400 atmospheres, or at a greater temperature than 1500°C. Indeed, it is probable that the vast majority of igneous and metamorphic rocks, as well as mineral veins, came into existence at considerably less depths, and at more moderate temperatures. It is true that most of the rock-forming minerals crystallize from their own melts at temperatures between 1,100°C. and 1,550°C., but they separate out from the complex magmas from which our igneous rocks were formed at lower temperatures, rarely much exceeding 1,200°C., and frequently considerably less. It has been found possible at the Geophysical Laboratory to maintain a temperature of 1,000°C. or more under a uniform pressure of 2,000 atmospheres for so long a time as may be desired, and, what is equally important, the temperature and pressure attained can be determined with satisfactory accuracy, the temperature within 2°C., and the pressure within 5 atmospheres. It has been ascertained that such uniform pressure as would ordinarily be present at the depths mentioned does not directly affect the physical properties of minerals to anything like the same extent as the difference between the temperature prevailing at the earth's surface and even the lowest temperature at which the igneous rocks can have been formed. It has, however, a most important indirect action in maintaining the concentration in the magma of a considerable proportion of water and other volatile constituents which have a far-reaching influence in lowering the temperature at which the rock-forming minerals crystallize out, in other words, the temperature at which the rock consolidates, and in diminishing the molecular and molar viscosity of the magma, thus facilitating the growth of larger crystals and the formation of a rock of coarser grain. They must also be of profound significance in determining the minerals that separate out, the order of their formation, and the processes of differentiation in magmas. It is, therefore, obvious that any conclusions derived from the early experiments which were carried out with dry melts at normal pressures must be received with very considerable caution. Nor does much advance appear to have been made, even at the Geophysical Laboratory, in experiments with melts containing large amounts of volatile fluxes, and yet, if we are to reproduce even approximately natural conditions, it is absolutely necessary to work with magmas containing a proportion of these constituents, and especially water, equal in weight to at least one-third or one-half of the silica present. This will obviously present considerable difficulties, but there is no reason to doubt that it will be found possible to surmount them.

A much more formidable obstacle in realizing the conditions under which rocks are formed is the small scale on which our operations can be carried on. There are important problems connected with the differentiation of magmas, whether in a completely fluid or partly crystallized state, under the action of gravitation, for the solution of which it would seem for this reason impossible to reproduce the conditions under which nature works. Instead of a reservoir many hundreds of feet in depth, we must content ourselves in our laboratory experiments with a vertical range of only a few inches. There are, however, other phenomena that require investigation and that involve a great difference of level in their operation, but do not take place at such elevated temperatures. Such are some of the processes of ore deposition or transference, especially secondary enrichment. Here, with the friendly assistance of mining engineers, but at the cost of considerable expenditure, it might even be possible to experiment with columns several thousand feet in vertical height.

In any attempt to reproduce the processes of metamorphism other than those of a purely thermal or pneumatolytic character, or to imitate the conditions that give rise to primary foliation, we must consider the effects of non-uniform or differential pressure involving stresses that operate in definite directions and result in deformation of the material on which they act. Unlike uniform pressure which usually raises the crystallization point, differential pressure may lower it considerably and thus give rise to local fusion and subsequent recrystallization of the rock. At the same time it profoundly modifies the structure, resulting in folds and fractures of every degree of magnitude. One of the most pressing problems of geology at the present moment is to determine the effects of non-uniform pressure in its operation at different temperatures, and in the presence of different amounts of uniform pressure, a factor which has probably an important influence on the result, which must also depend on the proportion and nature of the volatile constituents which are present, as well as on the time during which the stresses are in operation. There seems no reason why valueable information should not be obtained on all those points by properly conducted experiments.

The time element in the constructive or transforming operations of nature cannot, of course, be adequately reproduced within the short space of individual human activity, or, it may be, that of our race; but Dr. Evans is inclined to think that, even in the case of metamorphic action, the importance of extremely prolonged action has been exaggerated.

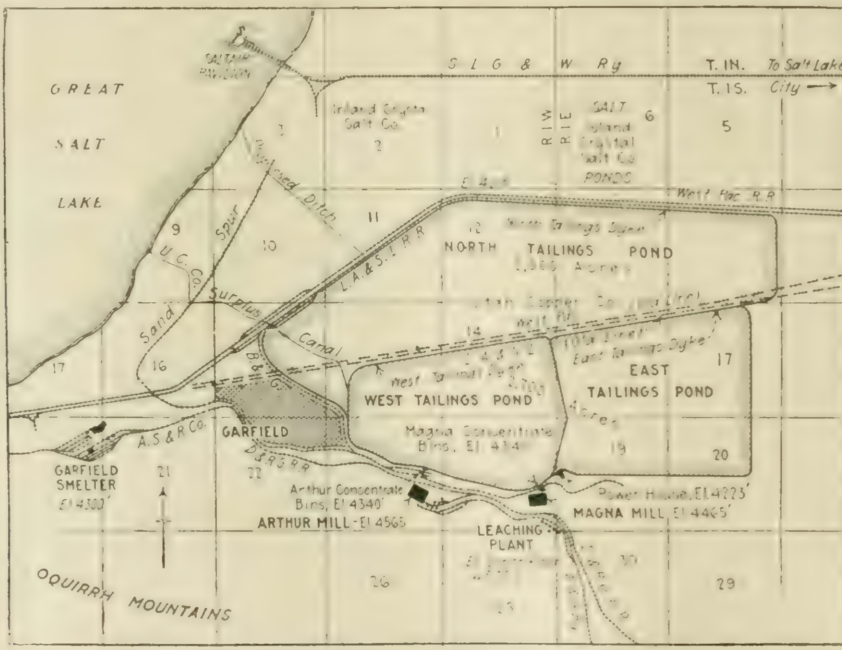
In attempting to imitate the natural processes involved in the formation and alteration of rocks and mineral veins, we require some means of ascertaining when we have approximately reproduced the conditions which actually prevailed. It is not sufficient to bring about artificially the formation of a mineral occurring in the rocks or mineral deposits under investigation, for the same mineral can be reproduced in many ways. It is, however, probable that a mineral produced under different conditions is never identical in all its characters. Its habit, or the extent to which its possible faces are developed (a function of the surface tension), the characters of the faces which are present, its twinning, its internal structure, inclusions and impurities, all vary in different occurrences, and the more closely these can be reproduced the greater the assurance we obtain that an artificial mineral has been formed under the same conditions as the natural product.

For this purpose it is above all necessary that there should be in the first place a systematic comparative study of these characters and of the association in which they are found. The results thus obtained should be of the greatest value in indicating the directions along which experimental work would be most probably successful. They should, of course, be supplemented by laboratory studies of the relations of such subsidiary crystallographic characters to the environment in the case of crystals which can be formed under normal conditions of temperature and pressure, and therefore under the immediate observation of the experimenter. Some work has, in fact, already been done on the effects on these characters of the presence of other substances in the same solution.

In the study of the secondary alterations of metalliferous deposits, especially those which consist of the enrichment of mineral veins by the action of circulating solutions, either of atmospheric or intratelluric origin, the study of pseudomorphs gives, of course, valuable assistance in determining the nature of the chemical and physical changes that have taken place.

A successful solution of the problem of the exact conditions under which deposits of economic importance are found would be of incalculable value in facilitating their discovery and exploitation, and would be the means of saving a vast amount of unnecessary labour and expense.

Utah Copper's Tailing.—*Chemical and Metallurgical Engineering* for September 1 quotes a paper read by H. C. Goodridge at a recent meeting of the Utah Society of Engineers, describing the method of impounding tailing from the concentrating plants of the Utah Copper Company, at Garfield, west of Salt Lake City. With its enormous tonnage the tailing problem is of unusual importauce. The early estimates of ore reserves at the mine in Bingham Canyon were 37,500,000 tons and, in 1907, the mill was expected to handle 5,000 tons of ore daily. By purchase of the Boston Consolidated and other properties in the canyon, the existing ore reserves were increased ten times, to 374,000,000 tons, despite mining in the meantime more ore than twice the original estimate. Milling during 1918 proceeded at the rate of 33,317 tons daily, and the rated capacity of the Magna and Arthur concentrators and the leaching plant is no less than 43,000 tons. This tenfold increase in available ore and ninefold increase in milling capacity has rendered insufficient the originally ample tailing area. A map shown herewith gives a general idea of the position of the mills and smelter near the Great Salt Lake shore. The southwestern portion of this mapped area is rough country. The Bingham & Garfield and Denver & Rio Grande railways skirt the Oquirrh Mountains, which rise directly out of the flatlands surrounding Salt Lake. Thus the mills are constructed on a hillside about 125 ft. above the general ground level to the north. Across this marshy flat some mile-and-a-half away were situated the main lines of two transcontinental railways, and the intervening area has been used for tailing since the commencement of operations. Various



MAP SHOWING THE TAILING PONDS OF THE UTAH COPPER COMPANY.

schemes for enlargement were studied by the company's engineers. If all the expected ore were impounded in the so-called west and east tailing ponds, dykes would be required around the area to an average height of 80 ft. and an eventual slope on top of the pond of only 0·5%. The total estimated cost of this scheme was $1,680,000. Another plan was based on making two independent ponds with dykes paralleling the two transcontinental railroads on the north and south, with a maximum height of 92 ft., at an estimated cost of $3,885,000. Such a mass of loose material in close proximity to the railroads would be a continual menace to their operation, and these schemes were abandoned. It then appeared necessary to move the railroads. If they were shifted about a half-mile north and connected with the old lines at the old Garfield station, a dyke about 30 ft. high would be needed to impound all tailing resting at a grade of 0·9%. The cost of this scheme was about $2,265,000. However, by moving the tracks still farther north, and rebuilding the Garfield station, a tailing area of 6,000 acres could be provided, sufficient for all material, at an average slope of about 0·92% without its toe encroaching on the railroads, with a dyke 12 ft. high to impound and clarify water before drainage into the lake. This plan, which was adopted, cost about $910,000, chiefly for new lands and railroad revision. The latter item was by agreement done without cost to the railroads, a new roadbed being provided equal to the old, $2,000 per mile allowed for extra surfacing work until the roadbed settled, and an amount capitalized at $46,000 for additional expense of operation due to added distance and curvature. The north tailing pond, which was originally from 6 to 12 in. under water, was first drained by digging the ditches eventually needed for tailing water, and the embankments were made by drag-line excavators at a cost of 25c. per yard. The 12 ft. dyke is 7 miles long, with a top width of 10 ft. for a railway track to handle riprapping, which latter is smelter slag placed for about 80c. per cubic yard.

The New Elmore Process.—Another patent relating to the new process invented by F. E. Elmore for the treatment of complex lead-zinc sulphides has been published during the past month. This is numbered 7,732 of 1918 (131,353). The specification is as follows:

This invention relates to improvements in the process of separating lead and zinc from ores, concentrates, or the like, in which these metals co-exist in the form of sulphides. It has been proposed to effect this separation by means of the differential action of sulphuric or hydrochloric acid alone, or of such acid in presence of a suitable salt, such as soluble chloride, whereby the lead sulphide is converted into a soluble compound while the zinc sulphide remains substantially unattacked. In the proposed processes the soluble lead compound, after separation from the unattacked zinc sulphide by means of a hot solvent, has been recovered by crystallization while the zinc sulphide has been further treated for the recovery of the zinc therein. The present invention relates to improvements in that form of the process in which hydrochloric acid alone, in the absence of a soluble chloride or like salt, is the acid agent employed for attacking the ore, and has for its object to provide a process characterized by economy in the consumption of hydrochloric acid and other materials, coupled with a high percentage recovery and degree of purity of the soluble lead compound produced.

According to one part of the invention the ore (which term includes concentrates and the like) is first heated at about 100°C. with a sufficient quantity of strong hydrochloric acid until substantially the whole of the lead has been converted into chloride in known manner, with evolution of sulphuretted hydrogen. The quantity of acid used should be as small as is compatible with efficient conversion of the sulphide into chloride. The mixture is now cooled, and any excess of hydrochloric acid is removed, along with soluble impurities present, by washing the lead chloride and mineral residue with a limited quantity of water. The lead chloride thus freed from soluble impurities is then extracted from the mass by means of a hot solvent which consists of a solution of lead chloride in water or in strong brine and which constitutes the mother liquor from previous operations. The hot solution, after separation from the undissolved matter, is cooled, whereupon a portion of the lead chloride crystallizes out and can be collected for use, preferably as hereinafter described, while the mother liquor is re-heated and used for extracting lead chloride from another batch of the ore. The extraction process thus becomes a cycle in which the same quantity of solvent serves continuously to convey the purified lead chloride from the treated ore to the crystallizing vat.

The following example illustrates this part of the invention. A lead-zinc sulphide ore from Burma containing 17·1% of lead and 42% of zinc is ground to pass through a 60 mesh standard sieve. Twenty kilos of the powder are mixed with 12 litres of strong hydrochloric acid (containing 330 grams of HCl per litre) in an earthenware steam-heated vessel and the mixture is heated at about 100°C. until the evolution of sulphuretted hydrogen has practically ceased. The mixture is now cooled, the excess of hydrochloric acid is removed along with soluble impurities present by washing the lead chloride and mineral residue with a limited quantity of cold water, and the lead chloride is then extracted from the mass by means of hot mother liquor at about 100°C. If the mother liquor consists of an aqueous solution of lead chloride, about 200 litres thereof may be employed for the extraction; if it consists of a solution of lead chloride in strong brine, about 150 litres may be employed. The hot solution, after separation from the undissolved mineral residue, is cooled, whereupon a portion of the lead chloride crystallizes out and is collected for use, while the mother liquor is again heated and used as hereinbefore described. The proportions mentioned in the foregoing example are merely illustrative. The best proportions to use in any given case will depend to some extent upon the nature of the ore treated and other conditions.

Owing to the employment of hydrochloric acid as the acid agent for attacking the ore, and the removal of soluble impurities from the treated mass as above described, the use of brine, which in certain localities is not easily obtainable, may be altogether dispensed with and the rejection of lead in the solvent liquor, necessitated by the accumulation of impurities therein, is reduced to a minimum. Further, the lead chloride obtained is of a high degree of purity. If, however, the solvent liquor contain brine, its impoverishment by the formation of sodium sulphate and the accumulation of impurities is reduced to such a degree that the consumption of salt and occasional loss of lead on rejecting the contaminated liquor are reduced to negligible proportions. A further benefit resulting from the removal of any remaining acid from the treated mass, prior to the extraction with solvent liquor, is that the latter remains substantially free from acid, and metallic pipes, pumps, vats, or the like may be employed with but little risk of contamination of the liquor or corrosion of the plant.

According to another part of the invention the above described process is improved by returning to the vessel in which the ore is attacked the hydrochloric acid consumed in forming the lead chloride. For this purpose the lead chloride obtained is heated with sulphuric acid whereby hydrochloric acid gas is evolved ; the gas is absorbed in water and the solution is used for treating a further batch of ore. The sulphuric acid required may be obtained by utilizing in known manner the sulphuretted hydrogen evolved during the attack upon the ore by the acid. By operating in this manner the process to a substantial extent constitutes an economic cycle in which the hydrochloric acid and (if brine be used) the sodium chloride are largely conserved. These considerations are of importance in the case of some ore deposits which are not favourably situated as regards supplies of hydrochloric acid and salt, since they render it practicable to treat the ore on the spot instead of transporting it to localities where such agents are readily obtainable. To effect a further saving in acid, it is in some instances advisable to subject the ore to a preliminary concentration so as to reduce the proportion of useless acid-consuming material present.

The lead sulphate made from the chloride may be mixed with lead sulphide and smelted in known manner, and the lead sulphide or part of it necessary for the purpose may be made by utilizing the sulphuretted hydrogen evolved on the treatment of the ore with hydrochloric acid.

The following are the claims : (1) Process of separating lead and zinc from lead-zinc sulphide ores, concentrates, and the like, consisting in heating the pulverized ore with a sufficient quantity of strong hydrochloric acid until substantially the whole of the lead has been converted into lead chloride while the zinc sulphide remains substantially unattacked, cooling the mixture, washing the mass with a limited quantity of cold water to remove excess of acid and soluble impurities, and then by means of the herein described cyclic process extracting the purified lead chloride and conveying it to the crystallizing vat. (2) Process of separating lead and zinc from lead-zinc sulphide ores concentrates and the like according to Claim 1, in which the lead chloride obtained is heated with sulphuric acid, the hydrochloric acid evolved is dissolved in water, and the solution is used for treating a further batch of ore.

SHORT NOTICES

Coal Mining.— At the September meeting of the Institution of Mining Engineers, D. S. Newy described a new way of working thick seams of coal, with special reference to practice at Baggeridge, Staffordshire.

Sampling.— In the *Engineering and Mining Journal* for August 30, J. H. Eggers discusses the application of small rock-drills in sampling mines.

Mine Mapping.—In the *Mining and Scientific Press* for August 16, Leicester C. Uren discusses the standardization of symbols for mine maps, and gives the symbols used in the University of California.

Surveys.—In *Economic Geology* for August, M. L. Fuller describes a quick method of reconnaissance mapping.

Petroleum Report Books.—In *Economic Geology* for August, E. G. Woodruff offers standard note-book forms and symbols for use by petroleum engineers.

Concentration at Mountain Copper.—In the *Mining and Scientific Press* for September 6, L. C. White describes the No. 1 concentrator at the Mountain Copper mines, Shasta County, California.

Silver.—At the September meeting of the Institute of Metals, Ernest A. Smith and Harold Turner read a paper on the properties of standard or sterling silver, with notes on its manufacture.

Electro-Plating.—At the September meeting of the Institute of Metals, R. E. Leader presented a paper on the early history of electro-plating with silver.

Solubility of Gold in Cyanide Solutions.—The *Journal* of the Chemical, Metallurgical & Mining Society of South Africa for July contains a paper by H. A. White detailing experiments on the solubility of gold in cyanide solutions.

Tin Alloys.—At the September meeting of the Institute of Metals, J. E. Stead and L. J. Spencer presented a paper on the ternary alloys of tin, antimony, and arsenic ; and F. C. Thompson and F. Orme one on the constitution and metallurgy of britannia metal.

Zinc-Dust.—In *Chemical and Metallurgical Engineering* for August 15, W. F. Edwards compares methods of estimating metallic zinc in zinc-dust and recommends the ferric ammonium-alum method.

Aluminium.—*Chemical and Metallurgical Engineering* for September 1 contains a paper by R. J. Anderson on the metallography of the aluminium ingot.

Ferro-manganese.—*Chemical and Metallurgical Engineering* for September 1 contains a paper by R C. Gosrow on the design of electric furnaces for the production of ferro-manganese.

Carbon-free Alloys.—In *Chemical and Metallurgical Engineering* for September 1, E. F. Northrup describes an electric furnace for producing carbon-free alloys

Determination of Magnetite.—In the *Engineering and Mining Journal* for August 23, F. G. Hawley, of the Miami smelter, gives a method of determining magnetite in copper mattes and slags.

Losses in Slags.—In the *Engineering and Mining Journal* for August 16, E. H. Robie gives the results of tests at the International Nickel Co.'s smelter at Copper Cliff, Ontario, in connection with losses of copper and nickel in slag.

Microscopical Studies of Iron Ores.—*Economic Geology* for August contains a paper by T. M. Broderick describing microscopical examinations of polished surfaces of magnetite and hematite ores undertaken partly with a view of studying their paragenesis.

Ontario Ore Deposits.—In the *Mining and Scientific Press* for August 16, Elsworth Y. Dougherty writes on the relation of regional deformations to the distribution of ore in the Pre-Cambrian, with special reference to the occurrence of ore deposits in Ontario and adjacent territories.

Klondyke.—In the *Engineering and Mining Journal* for September 6, Henry Boursin gives a new version of the history of the discovery of Klondyke.

Siberian Mining.—In the *Mining and Scientific Press* for September 6, C. W. Purington writes of present conditions at the Siberian mines.

Shasta County, California.—In the *Mining and Scientific Press* for August 23, Herbert Lang continues his reminiscences of metallurgy in Shasta County, California, discussing the Bully Hill copper zinc mine.

South African Coal.—A series of articles on the coalfields of South Africa starts in the July 19 issue of the *South African Mining and Engineering Journal*

Platinum.— In the *Engineering and Mining Journal* for August 30, W. L. Uglow commences a series of articles on the geology of platinum deposits.

West Shining Tree, Ontario.—In the *Engineering and Mining Journal* for August 16, L. H. Goodwin describes the West Shining Tree gold-mining district, south of Porcupine and west of Cobalt, Ontario.

Fuel Economy.—A report prepared by Dr. W. A Bone, Sir Robert Hadfield, and A. Hutchinson was presented at the September meeting of the Iron & Steel Institute on fuel economy and consumption in the manufacture of iron and steel. A similar paper on present practice in Germany was presented by Cosmo Johns and L. Ennis.

RECENT PATENTS PUBLISHED.

A copy of the specification of any of the patents mentioned in this column can be obtained by sending 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2. with a note of the number and year of the patent.

1,677 and 5,598 of 1918 (130,626 and 131,039). W. HEAP and E. NEWBERY, Manchester. Method of producing anhydrous chlorides.

12,364 of 1918 (131,675). H. A. BLACKWELL, Blackpool. Method of producing carbon-free ferro-titanium by the aluminothermic process.

12,778 of 1918 (126,269). WERF CONRAD, Haarlem, Holland. Improved suspension device for suction dredges.

13,210 of 1918 (119,224). W. A. SCOTT, Chicago. The use of a gaseous frothing medium in place of liquid frothing mediums in concentration by flotation, to be introduced with the air used in creating bubbles; acetylene is mentioned as such a gas.

13,231 of 1918 (118,629). G. A. GUESS, Toronto. Electrolytic method of separating nickel from copper.

13,369 of 1918 (131,702). ELECTROLYTIC ZINC CO. OF AUSTRALASIA, Melbourne. Method of removing cobalt from solutions obtained in the electrolytic method of recovering zinc from its ores.

13,792 of 1918 (131,460). C. DREYFUS and J. J. BLOCH, Manchester. Method of manufacturing alkaline manganates.

14,233 of 1918 (131,743). HORTON BOLITHO, Falmouth. Furnace for refining tin. We quote the following from the specification: "This invention relates to an improved process for roasting and refining impure tin and apparatus therefor. Tin as obtained by the smelting of its ores usually contains various impurities, which it is necessary to remove before the metal is suitable for commercial use. This refining has heretofore been accomplished by subjecting the impure metal to the action of the heated gases upon the bed of the reverberatory furnace, the gases coming into contact with the material operated upon. According to this invention, impure tin is refined by applying heat externally to a vessel containing the material, in such a manner that the metal is melted in the presence of a limited amount of air and out of direct contact with the furnace gases. It has hitherto been proposed in connection with apparatus for extracting metals from their ores to place the material to be treated together with fluxes in a closed inclined fireclay retort to the exterior of which sufficient heat is applied to fuse the metal sought to be obtained, the fluxes combining with the elements to be removed from the metals sought. In carrying the process into effect, I prefer to arrange the furnace with a tube of steel, iron, or other suitable material inclined slightly to the horizontal. Under the raised end of the tube is constructed a fireplace the flue of which extends parallel with the tube and so that the gases are in contact therewith during their passage to the chimney at the lower end. The tube is enclosed at each end by suitable doors, the lower end projecting over a receiver."

15,598 of 1918 (130,838). A. FERGUSON, Scorrier, Cornwall. Tin dressing. The following is Claim No. 1: "In apparatus for use in concentrating ores and the like, annularly arranged series of trays disposed radially, the said series being arranged as a pair, or two, or more, pairs, and in such relative positions that the matter under treatment, fed on to the trays of one series, passes therefrom on to the trays of another series."

15,691 of 1918 (130,840). J. B. PIERCE, Charleston, West Virginia. Method of making strontium peroxide.

16,446 of 1918 (130,882). D. TYRER, Stockton-on-Tees. Method of making sodium permanganate.

20,081 of 1918 (121,600). METALS DISTINTEGRATING CO., New York. Method and plant for producing finely divided metal by acting on a stream of molten metal by jets of steam.

9,430 of 1919 (131,858). G. H. T. RAYNER and P. RAYNER, Sheffield. Improved valve for rock-drills.

NEW BOOKS

Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

A Treatise on British Mineral Oil. By J. A. Green, and others. Cloth, octavo, 253 pages, with folding plates and other illustrations. Price 21s. net. London: Charles Griffin & Co., Ltd.

The shortage of liquid fuels of all kinds during the latter stages of the war brought into prominence the need for the investigation of the potential internal sources of supply of these products. The results of a certain portion of these investigations have inspired the production of this treatise on British mineral oil. In this volume the contributors have confined themselves strictly to the possibilities of production of such mineral oil by thermal decomposition of solid hydrocarbons, and have practically avoided reference to the contentious subject of the production of naturally occurring petroleum.

The book is divided into six sections, containing sixteen chapters, together with an appendix, index, and a bibliography on the chemical section.

Section 1, "The Raw Material," by E. H. Cunningham-Craig, deals with oil-shales, cannel coals and allied deposits, lignites, and peat. In it the author discusses in outline the relationship between the different types of bodies which yield liquid products on destructive distillation, the possible means of their formation, and their distribution in the British Isles. He states that the known deposits of oil-shale in these islands are far from being worked out, and are not even fully developed; also, that in addition to this source of oil, there are various canneloid deposits from which oil may be obtained in commercial quantities, claiming that there is a possible output of 4,000,000 tons per annum which is worth retorting. No mention, however, is made of the life of such at this rate of denudation, a very important point when the question of capital cost for erection of works has to be considered.

In Section 2, W. R. Ormandy deals with the "Retorting of Bituminous Materials." After dealing in a perfunctory manner with the wasteful consumption of fuel, the author discusses the action of heat on the raw materials, and then traces the development of retorting for the production of coal-gas from the earlier days to the present day, giving descriptions of modern gas retorts and coke-oven plants. Leaving what are the essentially high-temperature processes, he then describes some of the processes for low-temperature distillation, including the Tozer, Maclaurin, and Chiswick retorts. The table given of the results obtained with the Chiswick retort is to all intents and purposes valueless, as no reference is made as to the origin of the various classes of raw material used, although the individual members of each class show wide variations among themselves. The conclusions drawn at the end of this section are well worthy of study, being most valuable in presenting a comprehensive review of the situation of the low-temperature carbonizing industry at the present day. If these conclusions are well digested, both by exponents of low temperature carbonization and the general public, many of the rash statements that are being at present made would never be uttered.

Section 3, by A. E. Dunstan, deals with "Products from Low - Temperature Carbonization and Their Chemical Nature." Although there is nothing new in this section, it is a résumé that will give a good general idea of the subject to the junior student. For the true seeker after knowledge on the subject, however, the lack of references detracts very largely from its value; in fact, this lack of references is apparent in the whole of the volume. It is true that to this particular section a bibliography is appended, but it is very incomplete, and does not even discriminate between valuable researches and those of minor worth.

Section 4, "Refining," by A. Campbell, is an excellent outline of the refining operations necessary for the separation of the constituents of the products of low-temperature carbonization.

In Section 5, "Practical Experimental Work," F. M. Perkin deals with the proposed Midland testing station and its scheme of operations. One can hardly agree with the author in his ideas about the sizes of working experimental units, and would suggest that the £100,000 available for this work will soon be exhausted without giving practical results, if retorts of the capacity of 20 to 40 tons per day are to be erected as experimental units.

Section 6, "Power," by A. H. Seabrook, calls for little comment, the points he deals with being accepted axioms at the present day.

The whole question of low-temperature carbonization is a matter of £. s. d. If the advocates of the process can prove that it will be a paying proposition, then nothing will prevent its expansion. Unfortunately, in this volume, nothing but opinions are expressed, and as such carry little weight with the business man.

The publishers must be congratulated on the general get up of the book, which is of their best pre-war standard.

E. Lawson Lomax,
M.Sc., A.I.C., F.C.S.

Potash Recovery at Cement Plants. By Dr. Alfred W. G. Wilson. Bulletin 29 of Canadian Department of Mines.

Mineral Resources of Caucasia. By D. Ghambashidze. Cloth, octavo, 180 pages, illustrated. Price 8s. 6d. net. London: George Allen & Unwin, Ltd.

Mining and Manufacturing of Fertilizing Materials, and their Relation to Soils. By S. L. Lloyd, of Florida. Cloth, octavo, 160 pages, illustrated. Price 9s. New York: D. Van Nostrand Co.; London: Crosby Lockwood & Son.

Geology of India for Students. By D. N. Wadia. Cloth, octavo, 400 pages, illustrated. Price 18s. net. London: Macmillan & Co., Ltd.

Electric Mining Machinery. By Sydney F. Walker, Cloth, octavo, 375 pages, illustrated. Price 12s. 6d. net. London: Sir Isaac Pitman & Sons, Ltd.

Transvaal Chamber of Mines, 29th Annual Report, 1918. Cloth, quarto, 525 pages. Johannesburg and London: Transvaal Chamber of Mines.

COMPANY REPORTS

Dolcoath. — The report of this company, which works the celebrated tin mine at Camborne, Cornwall, shows that during the half-year ended June 30 the output exhibited a further decrease. The ore raised and treated amounted to 28,877 tons, and the tin concentrate extracted was 387 tons, as compared with 28,716 tons and 403 tons respectively during the latter half of 1918. The amount realized was £45,875, as compared with £76,103; the yield per ton of ore was 30·05 lb., as compared with 31·45 lb.; and the receipts per ton of concentrate were £118. 7s. 9d., as compared with £188. 15s. 3d. Other items of revenue brought the receipts to £48,016. The working cost was £67,526, and the loss for the half-year was £19,519, as compared with a profit of £14,446. The receipts per ton of ore treated were 33s. 3d., and the cost 46s. 9d., showing a loss of 13s. 6d. In the following paragraphs we quote the report of R. Arthur Thomas, the managing director:

The Williams shaft has contributed 40·6% of the total tinstuff drawn and 38·4% of the black tin sold, being a decrease of 3·4% and 2·2% respectively. The 375 fm. level is driven 35 fm. east of New Sump shaft in the foot wall granite and will shortly hole to the old workings from which it is expected to secure considerable quantities of low-grade tinstuff.

New Sump section of the mine has contributed 6·2% of the total tinstuff drawn and 9·3% of the total black tin sold, being a decrease in each instance of 2·2% and 4·5% respectively. Following the driving of the 338 fm. level, approximately 30 fm. east of the New East shaft, a cross-cut is being put out south which has proved the unworked portion of the lode in this district of the mine to be upwards of 18 ft. in width, giving an average value of 30 lb. of black tin per ton. It cannot be anticipated that there is any great extent of unworked lode in this part of the mine, but there is every reason to believe that large quantities of "run stuff" will be available in addition to that secured by stopes when this ground is properly opened up for working. After driving the 190 east of New Sump shaft for a distance of 20 fm. and holing to the old workings, a rise was put up from this level for a distance of 6 fm. 4 ft. preparatory to stoping this ground; subsequently a winze was started below this level to open up this tin ground for working in conjunction with the development at the 230 fm. level; the average value of the ground thus opened up has been 35 lb. of black tin per ton. The 230 fm. level has been driven east of New Sump 6 fm. 4 ft., and, although being driven on the foot-wall granite, it contains low quality tinstuff, which will subsequently pay for stoping, and will, in addition, open up large quantities of low-grade tinstuff which will help as a feeder to New Sump shaft, the major portion of the stuff broken in the region of New Sump workings now being transferred to and drawn through the Williams shaft.

Old Sump section of the mine has contributed 2·7% of the total tinstuff drawn and 1·2% of the total black tin sold, being a decrease of 6·1% and 1·9% respectively as compared with the last half-year.

The Eastern section of the mine has contributed 39·1% of the total tinstuff drawn and 37·6% of the total black tin from the mine, being an increase of 3·8% and 0·2% respectively as compared with the previous six months. The 400 fm. level has been driven 21 fm. west of No. 4 winze west of the Eastern shaft and produces 25 lb. of black tin to the ton of stuff. This end is being driven by hand labour and consequently the progress is slow, but there is every prospect of developing a very considerable tonnage of ore of about this value. Preparations are being made to work a section of tin ground from the 210 to the 254 fm. level west of the Eastern shaft; while this is not expected to be of high-grade quality, yet, at approximately the present price obtaining for tin, and having regard to the conditions of working, small margins of profit per ton can be secured.

Wheal Harriet section of the mine has contributed 9·6% of the total tinstuff drawn and 11·4% of the black tin sold, being an increase of 3·3% and a decrease of 1·8% respectively.

Stray Park section has contributed 1·8% of the total tinstuff drawn and 2·3% of the total black tin sold, as compared with 1·6% and 1·1% respectively for the preceding half-year. Toward the end of February last the driving of the 352 fm. level west of Stray Park shaft was resumed, it having been idle for many years. After driving about 11 fm. an improvement was met with of which the shareholders were advised on May 28 last. Since that time about 6 fm. has been driven on the lode, the average value of which has been 60 lb. of black tin to the ton of stuff. The lode in the end having become split into two parts, stoping operations were commenced to ascertain the main part of which the end should be extended further westward, to prove the width (which has been found to be over 12 ft.) and to prepare for sinking and rising below and above this level. Following this improvement, the driving of the 338 fm. level west of Stray Park shaft was commenced which has been so far driven 3 fm. 4 ft., the lode producing 16 lb. of black tin to the ton of stuff. At a distance of 45 fm. west of Stray Park shaft a cross-cut has been driven 6 fm. south at the 375 fm. level to intersect the portion of the lode referred to as having been found at the 352 fm. level. This cross-cut has been driven 6 fm. 4 ft., and, although altered granite has been met with containing a few narrow branches of lode stuff, the main portion has not been intersected.

Unfortunately the company is not in a position to undertake extensive development work, which for the period under review has been only 76 fm. 4 ft.; but, as will be observed from the foregoing report, this important branch of mining operations is being gradually increased as circumstances permit.

The total driving on lodes was 64 fm. 4 ft.; the driving on cross-cuts was 5 fm. 1 ft.; and rising 6 fm. 4 ft.; total 76 fm. 4 ft.

At the meeting of shareholders, Mr. Thomas mentioned that owing to poor results of development the Eastern mill would be closed. He also intimated that arrangements were being made to sell the produce by private contract instead of at the Redruth tin ticketings.

Tin Fields of Northern Nigeria.—This company operates alluvial tin ground on the Fedderi river, Nigeria. S. R. Bastard is chairman. The report for the year ended March 31 shows that 118 tons of tin concentrate was won and that the profit was £2,956. In April and December, 1918, dividends totalling £7,700, 15%, were distributed.

Lucky Chance.—This company operates the Murgi alluvial tin properties in the Bauchi province, Northern Nigeria, and at the beginning of 1918 acquired the West Poldice tin and wolfram mine and dumps east of Redruth, Cornwall. The company also holds a large number of shares in the Berrida company, which owns the Poldice mine and dumps. S. R. Bastard is chairman. The report for 1918 shows that 28 tons of tin concentrate was won from the Nigerian properties. Nothing has yet been done at the West Poldice property, but concentration was commenced at the Poldice on August 11. The report shows a profit of £419, which was carried forward.

South Kalgurli Consolidated.—This company was formed in 1913 as an amalgamation of the South Kalgurli and Hainault companies, which had for some years worked adjoining mines at Kalgoorlie, West Australia. Neither company ever paid big dividends, and the amalgamation was arranged for the purpose of facilitating further exploration. This new development work has proved distinctly successful. John Morgan is consulting engineer, and J. M. Embleton is manager. The report for the year ended March 31 last shows that 96,239 tons of ore was sent to the mill, where gold worth £128,556 was extracted. The net profit was £9,620, out of which £9,375 has been paid as dividend, being at the rate of 7½%. The development work has been concentrated on the new No. 3 East lode, and the results as already mentioned have been favourable. The reserve of proved ore is estimated at 155,944 tons averaging 7·48 dwt. per ton, and of probable ore 108,785 averaging 6·04 dwt. per ton. The proved ore reserve shows an increase of 30,589 tons and the probable ore reserve an increase of 20,000 tons. The average grade of the proved ore reserve is 1·5 dwt. higher than the year before, owing to the large amount of 10 dwt. ore developed on the new lode.

Mount Morgan Gold.—This company operates the celebrated gold-copper mine near Rockhampton Queensland. The report for the year ended June 1 shows that 124,747 tons of smelting ore was raised, together with 191,581 tons of concentrating ore. In addition 6,936 tons of smelting ore was obtained from the open-cut. At the smelter, 128,543 tons of ore, 17,348 tons of jig concentrate, 43,147 tons of sintered table and flotation concentrates, 112 "special" table concentrate, 6,406 tons of Many Peaks fluxing ore, and 395 tons of "sundry" ores were treated for a yield of blister copper containing 6,268 tons of refined copper and 92,983 oz. of gold. In order to afford an additional income as an offset against the fall in copper and the difficulty in marketing it, an increased amount of silicious gold ore from the upper levels was mined. The profit for the year was £111,640, out of which £100,000 was distributed as dividend, being at the rate of 10%. The reserve remaining at June 1 was calculated at 3,622,892 tons averaging 2·58% copper and 6·13 dwt. gold, but it has to be remembered that ore is continually mined from ground outside the calculated reserve. The report gives the detailed results of concentration and smelting during the second half of the period under review, that is to say, the six months ended June 1. The amount of ore sent to the concentrating plant was 75,138 tons of ore averaging 2·06% copper and 5·71 dwt. gold. The concentration products were: jig concentrate 7,221 tons averaging 2·43% copper and 4·03 dwt. gold, table concentrate 14,853 tons averaging 3·07% copper and 11·45 dwt. gold, and 5,581 tons of flotation concentrate averaging 14·96% copper and 26·5 dwt. gold. At the smelters the following were treated: 60,306 tons of ore averaging 2·1% copper and 10·59 dwt. gold, 7,345 tons of jig concentrate, 16,827 tons of sintered table and flotation concentrate, 6,085 tons of Many Peaks ore averaging 1·36% copper and 0·18 dwt. gold, and sundries 124 tons, total 90,687 tons, yielding blister containing 2,687 tons of copper and 50,041 oz. gold.

Hampden Cloncurry Copper Mines.—This company operates a group of copper mines in the Cloncurry district, North Queensland. The control is in Melbourne, and Erle Huntley is manager. The report for the half-year ended February 28 shows that the amounts raised from the various mines were: Hampden 5,127 tons, MacGregor and Wallaroo 2,565 tons, Trekelano 7,427 tons, Mascotte 231 tons, Answer 556 tons, Magnet 458 tons, Pindora 682 tons, McNamara 535 tons, Duchess 967 tons, fluxing ore from Salmon and Dingo 8,494 tons, total 27,042 tons. The smelter treated 30,135 tons, which included 3,503 tons of custom ore. The output was 1,758 tons of blister copper, containing 1,736 tons of fine copper, 1,314 oz. gold, and 4,193 oz. silver. The mines and smelters were only working from the end of November to the end of the company's half-year owing to a strike. The operations resulted in a loss of £53,973, to which must be added also an allowance of £12,610 for depreciation. The reserves of smelting ore at the various mines are estimated as follows: Hampden 25,000 tons averaging 6%, Duchess 25,000 tons averaging 11%, MacGregor and Wallaroo 27,500 tons averaging 5%, Trekelano 43,000 tons averaging 10%, Answer 1,600 tons averaging 8½%, and Mascotte 900 tons averaging 14%. The reserves of concentrating ore are: Hampden 44,000 tons averaging 3%, and Pindora 51,000 tons averaging 3%. In addition, the Magnet, McNamara, and Arbitration mines are estimated to contain 3,000 to 4,000 tons averaging 12½%, and the MacGregor 60,000 to 70,000 tons averaging 2½ to 3%. At the present time only a small amount of Hampden low-grade ore is being concentrated. At this mine an experimental roasting and leaching plant, with a capacity of 10 tons per day, is being erected.

Lake View & Oroya Exploration.—This company was formed in 1911 to combine the exploration and financial business of Lake View Consols and Oroya Exploration, two companies that had previously made their money out of the gold production of Kalgoorlie. F. A. Govett is chairman, and J. A. Agnew and J. H. Cordner-James are on the board. The report for the year ended June 30 shows that the profit was £27,088, of which £20 000 was placed to reserve. As mentioned in our last issue, £51,565 of the reserve fund is to be capitalized, and 103,130 shares of 10s. each are to be distributed among shareholders as a bonus, being at the rate of one for every seven held. The directors' report contains the following information as to the company's holdings:

Burma Corporation, 100,000 shares of £1 each, and Bawdwin Syndicate, 7,250 shares of 14s. each. The holding in the Bawdwin Syndicate has been increased during the year by the purchase of 2,250 shares at 46s. The Bawdwin Syndicate has an issued capital of £105,000, divided into 150,000 shares of 14s. each and holds 83,615 fully-paid shares in the Burma Corporation. The value of these interests has more than doubled during the year under review. Considerable further progress has been made in the development and equipment of the Burma Corporation, though the magnitude of its programme of operations still makes difficult any forecast as to when dividends may be expected.

Zinc Corporation, 20,940 20% preference shares of £1 each, and 51,100 ordinary shares of 10s. each. The company has a strong financial position and the past year's work was satisfactory, but owing to the industrial situation the operations of the company have been suspended during the current year for a long period. There are, however, some signs of better conditions, while the outlook as regards the prices of metals is favourable.

General Petroleum Corporation (California), 7% preference stock, $173,100, and common stock, $104,900. In common with other oil companies this company has benefited greatly by the large demand for products and highly remunerative prices. The quotation for the common stock has risen considerably in America during the course of this year, and the price of this and of the preference stock is further appreciated in London in consequence of the heavy fall in exchange. $18,100 additional common stock has been acquired at par during the year.

The Brixworth Ironstone Co. is entirely the property of the Lake View company. There is no change to report in the position of this company. During the year it has paid a dividend of 30%.

Trinidad Leaseholds, 3,688 shares of £1 each. An option to take additional shares at 30s. premium has been exercised and the Lake View holding thereby increased as compared with last year. A first dividend of 10% was paid in March last, and from the fact that a steady monthly output of over 14,000 tons is being maintained, and that the recent issue of capital has provided for outlays which were formerly financed out of revenue and loans, it is hoped that larger distributions will be made.

Granville Mining Co., £75,466 6% debenture stock, £360 prior lien debenture stock, receiver's certificates, £700, and 41,142 shares of £1 each, fully paid; North West Corporation, receiver's certificates, £7,000, 16,707 shares of £1 each, fully paid. The position of these interests is now far better than at this time last year. The litigation referred to in last year's report has been settled, and provisional arrangements have been made to re-finance the Canadian Klondyke Company, while a scheme has been prepared to provide the North-West Corporation with sufficient working capital and a dredge so that work may start next year. It is believed that there will be no great difficulty in carrying this scheme into effect.

Maikop Combine, 61,797 shares of 10s., fully paid. The position of the company would seem to be more hopeful; it has maintained a steady output of oil throughout the year, which it has sold for an immense amount of roubles. Whatever may be the value of the roubles, this steady output is a vast encouragement to those who have not abandoned their faith in the ultimate future of this field. In the meantime, this interest could be sold for at least £10,000.

The following valuation of the above interests is made at or under the market quotations, except in the case of the Brixworth Company, which is valued at cost: Burma Corporation, 100,000 shares, at 9¼, £925,000; Bawdwin Syndicate, 7,250 shares, at 4¼, £30,800; Zinc Corporation, preference, 20,940 shares, at 2⅜, £49,700, and ordinary, 51,100 shares, at 20s., £51,100; General Petroleum, preference stock, $173,100, at 110, £38,000, and common stock, $86,800, at 180, £31,000; Trinidad Leaseholds, 3,688 shares, at £3, £11,000; Brixworth Ironstone, £11,000; Maikop Combine, £10,000; total £1,157,700; to which must be added cash and liquid assets £63,000; total £1,220,700.

The company holds the following other interests about which there is nothing of special importance to report: Lake View and Star, 565,844 shares of 4s. each, fully paid; Babilonia Gold Mines, 150,007 shares of £1 each, fully paid; Leonesa Mines, 551,345 shares of 4s. each, fully paid; Mount Morgan, 500 £1 shares, fully paid; Nechi Mines (Colombia), 2,000 preference shares, 10s. each, fully paid; Yuanmi Gold Mines, 169,036 shares of £1 each, fully paid; Great Fitzroy Mines, 6% First Mortgage "A" Debentures, £8,024; Natomas Company of California, preferred stock, $18,900; Oroya Links, 25,000 shares of 5s. each; and Queenhills Gold Mines, 1,000 shares of £1 each; and a few others of insignificant amount.

The Mining Magazine

W. F. WHITE, *Managing Director*. EDWARD WALKER, M.Sc., F.G.S., *Editor*.

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938*. Telegraphic Address: *Oligoclase*. Codes: *McNeill*, both Editions

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION: U.K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XXI. No. 5. LONDON, NOVEMBER, 1919. PRICE ONE SHILLING

CONTENTS.

—4

EDITORIAL

SOME months ago the leading petroleum firms combined to endow, in an exceptionally handsome manner, the chemical department in the University of Cambridge. The benefaction might appropriately be extended to the geological department, where a lectureship in economic geology has recently been established, under the direction of Mr. R. H. Rastall. Geology is probably of as great assistance as chemistry in the petroleum industry, and the widening of the opportunities of its study might equally be the care of the oil kings.

CAMBORNE School of Mines has not had long to wait for a Principal, after the Governors made it known that they were desirous of making a permanent appointment. In Mr. Alexander Richardson they have found a man of the right type. A practical miner, with plenty of experience, especially in the Transvaal, he is also a keen student of the principles of mining and the collateral sciences. During the year 1913–14 he was president of the Chemical, Metallurgical, & Mining Society of South Africa. He has been a demonstrator at the Royal School of Mines, and he served for two years as secretary of the Privy Council's Committee of Research. For some time he was Johannesburg correspondent of this Magazine, and our readers know him well as the writer of reviews which are as informative as the books themselves.

ONE of the most inspiring and lovable professors of geology is Mr. T. W. Edgeworth David, of Sydney University. His influence is such that all mining graduates from Sydney are geologists. His work at the Front in France was of incalculable value, for not only did his geological knowledge prove of use in the campaign, but his freedom from departmentalism and petty jealousy placed his services and advice freely at the disposal of all with whom he came in contact. He is far from being a young man, and his undertaking the formation of an Australian mining corps, and subsequently the position of geological adviser on the French Front, entailed no small amount of self-sacrifice and personal discomfort. We have not seen his name in the honours lists, but perhaps the kind words and keen appreciation expressed by his brethren of the Geological and the Royal Geographical Societies are a better acknowledgment of the high quality of his work.

IN this issue Mr. Henry F. Collins commences a series of articles on the china-clay industry of the West of England. China clay is a mineral that has not hitherto come very much within the purview of members of those branches of the mining profession for which this Magazine caters. This condition of things has, however, been altered lately by the acquisition of the Clifden estate by Tehidy Minerals, Ltd. The industry is a bigger one than is usually supposed by our readers, and those connected with it have the advantage over the operators of tin mines in that they have the control of the market for their output, instead of being at the mercy of that vague abstraction, the middleman.

LABOUR troubles have caused the temporary suspension of the publication of many of our contemporaries in New York, of which we miss particularly the *Engineering and Mining Journal* and *Chemical and Metallurgical Engineering*. The demand for further increases in wages on the part of the machine-room hands in the printing department was out of all reason, and the publishers declined to entertain the proposals. Consequently the October issues have not yet been printed, and the position continues to be obscure. This episode is additionally distressing, because in the first issue in October of the *Engineering and Mining Journal* the new editor, Mr. J. E. Spurr, would have made his bow, while in the case of *Chemical and Metallurgical Engineering* a transition was to have been made from semi-monthly to weekly.

EVIDENCE was presented last month by the Institution of Mining and Metallurgy to the Royal Commission on Income Tax. The evidence in chief consisted of a statement by Mr. P. D. Leake, a chartered accountant who is well known in the mining world as an authority on wasting assets. This statement had been prepared by instruction from the Council of the Institution, after the whole matter had been exhaustively discussed by various committees. It filled eleven closely-printed pages of foolscap size, and it is too lengthy and too technical from the accountant's point of view for reproduction in our pages. In any case our readers require no conversion to the view that a mine is a wasting asset. Moreover, the arguments are aimed specially at the Inland Revenue authorities, and the case is handled accordingly. Briefly, the contention is that the total assets of a company should always be conserved, that there should be no fictitious entries in the balance-sheet representing assets in the shape of mining property which are continually diminishing in value, and that a certain proportion of current profits should be allocated to the replacement of part of the property account, before the profits are assessed for income tax. The question then arises as to how the company shall compute what is here called the "base value of the mining rights," that is to say, the actual total amount representing the property which is redeemable out of profits. It is clear that this amount cannot be fixed as the nominal capital of the company paid as purchase price, for under such circumstances the device of inflating the capital might cheat the public revenue of income tax entirely. The proposal involves the formation of some sort of tribunal or committee to decide the base value in every case, so as to arrive at a reasonable estimate, somewhere between the actual cash spent on the mine in plant and development, such as is the present practice with the Revenue Authorites, and the inflated nominal figure beloved of the promoter. The statement also provides another view of the present position of the income tax, and argues that, as the State now takes 30% of the profits of all companies, it should consider itself not just a tax-collector but a commercial partner and sharer of profits. From this point of view the State would have a direct interest, not only in the profits, but in the continued prosperity of the ventures. By establishing a tribunal that could fix the fair base value the way toward State participation would be cleared. There are a number of other points in the evidence that are deserving of notice and approval, such as the abolition of the three years average and the payment of the tax in half-yearly instalments, but these are mere details as compared with the establishment of a base value of the property, and its gradual redemption out of profits before the profits are subjected to assessment for income tax.

The Hampton Plains Discovery.

Since the last issue, two cable messages have been received in this country giving the opinions of Mr. A. Gibb Maitland, Government Geologist, and Mr. C. S. Honman, with regard to the gold discoveries at Block 50, Hampton Plains, West Australia. Mr Honman used to be field geologist under Mr. Maitland, and has recently been employed by Hampton Properties, Ltd., to make a geological report on Block 50, and in particular on the recent discovery known as the Celebration Lode. The cable messages were meagre and not easily understood, but we are fortunate in having had the assistance of Mr. C. M. Harris in interpreting them. The following explanation comes from his pen; it should be read by reference to the map published in the October issue of the Magazine. Mr. Maitland says that the deposits are not a continuation of those at Kalgoorlie, but of a westerly parallel channel. The Celebration lode is described as consisting of bedded veins, which will probably prove lenticular. Mr. Honman says that the lode is identical in characteristics with the Kalgurli lode, and shows the same sequence of rocks as in that mine, including quartz-dolerite and calc-schist in close proximity to the lode. The evidence of these two cables may appear conflicting, but Mr. Maitland's conclusions are based on the view given by Mr. Honman in 1916, in Geological Survey Bulletin No. 66, to the effect that the greenstone belt is a continuation of the western line, called the Somerville channel, running to the west of and parallel to the greenstone belt which runs from the Boulder mines through Feysville and probably to the east of Block 50. The question as to the actual greenstone belt is immaterial, if the rock characteristics are similar. Mr. Honman says that the characteristics are identical with those of the Kalgurli lode, that is, calc-schist and quartz-dolerite. This means that it is similar to the central lode-channel of the Golden Mile, intermediate between the lodes in the calc-schist on the eastern side of the belt and those on the western side, such as the Great Boulder and Ivanhoe lodes, which latter are found in quartz-dolerite only. Although the record of the Kalgurli line of lode is not as good as that of the Boulder and Ivanhoe lodes, it has been a valuable property for many years. The Government Geologist's view that the formation consists of bedded veins which will probably prove to be lenticular is an eminently safe one, but he might have dwelt more fully upon a question of such vital importance to the mining industry of West Australia. The mine managers who hold the option on the Celebration lease are being attacked in the local papers because they will not give an opinion as to the future possibilities of the property. They, however, prefer to remain silent until they can secure more evidence of the nature of the lode when it reaches the sulphide zone. The whole question depends on how far the lode will continue in the quart-dolerite until it passes entirely into calc-schist. Development alone will prove this, and, to the credit of the option-holders, it may be said that they are pushing on this work with all speed.

Burma Corporation.

The annual report of the directors of the Burma Corporation is reproduced in full in the section devoted to company reports, and the advertisement pages contain the Chairman's speech at the meeting of shareholders. Descriptions of the ore-body have so often appeared in these pages that it is not necessary to recapitulate on this occasion. The most interesting feature of the present situation is that connected with the smelting of the ore. In the issue of the Magazine for December, 1918, Mr. Lawrence Addicks' concentration scheme was given in full. According to this plan a lead concentrate with a lead-zinc ratio of 6 : 1 is produced, together with a zinc concentrate averaging 48% zinc and 8% lead, while the middlings would remain for treatment by chemical, smelting, or concentration methods. Since that time Mr. R. G. Hall and Mr. L. J. Mayreis have further studied the smelting programme, and they prepared a modified plan of campaign. They found that the type of slag could be changed in such a way as to carry 20% or more of zinc. This slag would carry away 4% of lead, but on the other hand the amount made would be proportionally smaller, and there would be the additional advantage that an improved fluxing situation for foul charges would be obtained. The plan further provided for the recovery of the metals in the slag by re-treatment in a reverberatory, using mill tailing as flux. The only drawback in connection with this scheme was the high price of fuel, which would be a serious cost in reverberatory smelting. The situation would, however, be eased when the Nam Ma coal deposits are developed and the value of the coal demonstrated. In the meantime the Ganelin chloride process, on which Mr. Queneau has been engaged for the last two years or so, has arrived at a practical stage, and moreover the new Elmore process has engaged the attention of several members of the board. The metallurgical problem has, in consequence, changed slightly in aspect, and it may eventually prove the best policy to omit the reverberatory, smelt cleaner in the blast-furnace, and treat the middlings by the Ganelin or chloride process or the Elmore process. Until the relative advantages of the smelting with blast-furnace and reverberatory and the smelting in the blast-furnace in conjunction with the chloride or Elmore process are definitely settled, the smelting programme will not go farther than the erection of new blast-furnaces to treat 1,000 tons per day and produce 60,000 tons of lead and 5,000,000 oz. of silver per year. As regards the treatment of the zinc concentrate, the plan, as already outlined in these pages, is to erect a distilling plant with a yearly capacity of 25,000 tons of concentrate at a point close to the iron works of the Tata Iron & Steel Co. in India. This plant should have an output of 10,000 tons of zinc per year, and the output of sulphuric acid from the roasters is estimated at 30,000 tons.

As regards the new processes mentioned, the Ganelin or chloride process, as improved by Mr. Queneau, was described in the Magazine for August, 1918, while the patents of the new Elmore process have been given in several recent issues. The Chemical and Metallurgical Corporation, the owner of the Elmore patents, is arranging to buy 150,000 tons of material, and to treat it on a profit-sharing basis, allowing the Burma Corporation a first profit of £4 per ton. This material will be treated at the Elmore works in this country, and if the results are satisfactory, the Burma Corporation will have the option of using the process at the mine, subject to the payment of royalty. The chloride process will be worked in this country, on a scale calling for 100 tons of middling per day. Two remarks by Mr. Addicks deserve attention. One is that none of these new processes will displace smelting for the treatment of ordinary concentrates, and the other is in connection with the chloride process: "provided tests show that the resulting zinc concentrate already produced is an acceptable smelting product."

The Cornish Tin Ticketing.

The desertion of the Tin Ticketing by three of the largest producers, East Pool & Agar, Dolcoath, and South Crofty, came as a matter of no surprise; the surprise has been that the mines should have so long continued to support this crude method of selling their tin concentrate. In May, 1912, we published in this Magazine an article on this subject written by Mr. Harold E. Fern, the present London representative of the Cornish Chamber of Mines, in which he conclusively proved, by means of figures and diagrammatic charts which were not challenged, as a result of his own experience of the sale of Cornish tin concentrate, that the returning charge under this method of sale was exorbitant, that there was insufficient competition, and that the sellers seldom secured the full advantage of a rise in the price of tin.

For the benefit of readers who are not familiar with the method of sale by ticket, we may say that these Ticketings are held fortnightly at Redruth. A few days previously, a mine, having tin concentrate for sale, either sends samples by post to the smelters, or representatives of the smelters call at the mine to take samples, and on these the smelter is supposed to base his bids. The concentrate is wet, and, on other than parcels of slime tin, averages from 6 to 8% of moisture. It has been suggested, as the concentrate is not re-sampled on delivery at the smelting works, that this affords an opportunity to a dishonest mine manager to liberally water the parcel and so add to the weight. We have never heard of such a case, and we believe the smelters figure on an average arrived at as the result of long experience. Of course, in hot weather, when the concentrate is in transit to the smelting works, the evaporation is often considerable. The smelters bid on each parcel of concentrate submitted, commencing with the mine offering the largest quantity. There probably is some competition for the first few lots offered, but so soon as a smelter has filled his requirements of a certain class of concentrate, his desire to purchase becomes less, with a consequent effect on his bids. The variation in the bids of the different smelters for the same parcel of ore is sometimes as much as £16.

According to the ancient tinner's laws, an allowance of 3 lb. per cwt. of concentrate was made for the turn of the scale, but this originated in the days when the seller took tin metal in exchange, and conditionally upon the same draftage being allowed upon all the tin metal delivered against black tin. However, with the passing of this old custom and the purchase of black tin for cash, there was no good reason why such a deduction should continue, but the smelters have persisted in its continuance. With tin at present prices, this draftage of 60 lb. per ton of concentrate is alone approximately worth £5. So that, in effect, to be paid for one ton of concentrate, the mines selling tin at the Ticketing have to deliver 2,300 lb.

The returning charge is really payable in *kind* and not in cash, as is the case everywhere else, and of course varies in monetary value with the price of tin, this deduction being $1\frac{1}{4}$ from the product per 20, that is approximately $6\frac{1}{4}$%. Of late the total returning charge for concentrate sold at the Ticketing has figured in some cases at over £30 per ton, whereas £15 to £18 should show the smelter in this country a fair profit at the present time. Under the contract system the ores will be paid for at the average, for the two weeks after sampling, of the official three months' quotation for standard tin, subject to an agreed treatment charge. Assays of buyers and sellers are exchanged as usual, and if the difference exceeds one per cent, there is a reference assay made by an independent assayer. Moisture is ascertained and deducted at the time of weighing, the ore being paid for at per ton of 20 cwt. dry weight. By this method, payment is received on the actual content of the dry ore, at the ruling price of tin, less a known returning charge, which only varies if the actual content falls below 68%. We cannot understand anyone preferring the Ticketing method.

The principal objection urged against the change appears to be that shareholders will not know the weight and value of the sales from month to month, but this can surely be met by the publication in the financial press of the monthly sales, weight and net value. Two of the mines concerned already do this.

The Future of Prospecting.

The meeting of the Institution of Mining and Metallurgy held last month was one of unusual interest. In the first place, it is not often that a paper written by an Australian engineer is presented in person, an advantage which is obvious, especially when the matter to be discussed is of direct application to the policy to be pursued by the mining profession. Secondly, the subject of the paper, prospecting in West Australia, has been receiving, during the past two months, the keen attention of everybody connected with mining, owing to the success of the methods instituted recently at the recommendation of the author himself. The thirdly follows from what is implied under the first heading, that is to say, the question of the organization of prospecting is one of the future problems for the profession, the financiers, and the Governments, and is already receiving the attention of the Institution and other bodies from this point of view.

The author, Mr. C. M. Harris, called his paper "Prospecting for Gold and other Ores in West Australia." The first part of the paper was devoted to a description of the method of prospecting for hidden outcrops, called "loaming," originated in Victoria, and more recently introduced in West Australia. This description is quoted in the Mining Digest elsewhere in this issue, and reference to it will be made later in this article. In the second part of the paper Mr. Harris described the work done, mostly under his own guidance, by the West Australian Department of Mines, for employing returned soldiers as prospectors, and he then proceeded to discuss, on broad principles, the best plans for the systematic examination of the earth's surface for the discovery of valuable mineral deposits. The third section of the paper contained a record of the known occurrences of the useful ores in West Australia. This we intend to reprint in the December issue. As considerable space was given in the October issue to the discovery of gold on Hampton Plains as a direct outcome of the new campaign of prospecting, nothing more need be said here on the subject, nor need we describe again the inauguration of the campaign, for reference was made to it last month, and also in the issue of May. Before going further, it is convenient here to mention that on another page Mr. Harris gives a history of the successive discoveries of gold in West Australia, a record which will prove to be of permanent value.

In introducing his paper, Mr. Harris referred first to the work done under the auspices of the West Australian Government. The first step to be taken was the mapping by the Geological Survey of such areas as might contain gold and other ores. Prospecting parties were then organized to examine individual belts of country, preferably those near the contact of the greenstones and granite. Particular note is taken of changes in the nature of the country. Pieces of quartz, jasper bars, and sometimes the outcrop of a quartz lode will decide a party to form a camp and make systematic trial. If floaters of ironstone, quartz, or lode matter are found, they are dollied, and should any prospects of gold be found, the general direction in which they have travelled is carefully and methodically followed. As soon as the prospector finds any traces of gold, he starts to "loam"; the details of the method are described in the reprint of this part of the paper in the Mining Digest. When he is satisfied as to the probable strike of the hidden outcrop, he sinks a costean or a small shaft through the cement, and drives a cross-cut underneath the cement to cut the lode. Constant use of the dolly is then necessary, and the capable prospector will soon ascertain whether or not it is worth while continuing. This method is more reliable than costeaning, and enables a prospector to get his results much quicker. Mr. Harris proceeded to tell how the Department of Mines gives instruction to intending prospectors as to the nature of the usual commercial minerals, and provides means for assaying samples. Here we may remind readers that in Rhodesia two years ago similar instruction was provided and an intensive lecture course was given by Messrs. F. P. Mennell, H. B. Maufe, A. E. V. Zealley, and A. J. C. Molyneux. An account of this work was given in the Magazine for September, 1917. Note of the details might well be taken by those who follow the subject further.

In the discussion that followed the introduction of the paper, Messrs. S. J. Truscott, A. E. Kitson, H. S. Denny, E. P. Rathbone, W. H. Trewartha-James, E. T. McCarthy, and E. O. Teale took part. Three points received special attention. One was the respective importance, for the discovery of new ore deposits, of the practical experience of the working prospector and of the scientific knowledge of the expert geologist. Another was the best conditions under which prospecting parties could be organized, whether by individuals, big corporations, or the Governments. A third was the occasional unreliability of experience in the search for the habitat of the gold, and the necessity for being continually on the alert for new modes of occurrence. The discussion was at its highest level of excellence when Mr. A. E. Kitson was giving some of his experiences and views. Mr. Kitson, though of English birth, learned and practised geology in Australia before becoming Government Geologist in West Africa. He combines in a remarkable degree the scientific wisdom of the mining geologist with the practical method of the prospector, and to him we look for the sound advice if and when an Imperial prospecting organization is established. With regard to the directing and financing of comprehensive schemes of prospecting, the way is far from clear at present. It would require much pluck in these days to ask any government to assume additional financial responsibilities, while corporations are more interested in securing a large property cheaply than in conducting prospecting expeditions, and no doubt rightly so. Theoretically, of course, the people who make money as a result of the prospectors' work ought to be called on to contribute to the maintenance of prospecting parties. For instance, the appreciation in the share value of Hampton Properties, Ltd., consequent on Hansen's discovery on Block 50, would keep a hundred prospectors at work for ten years under trained leaders. Can we induce any of the fortunate shareholders to devote a share of their profits to the prospectors' fund controlled by the West Australian Department of Mines?

REVIEW OF MINING

Introduction.—The feature of the past month has been a flood of prospectuses of new companies dealing with industrial ventures of all sorts. Most of the issues have been readily absorbed. The position in Russia is causing renewed anxiety, for the Bolshevist forces have the upper hand again. The price of silver continues to soar, and occasionally goes above coinage value, so that the Government is having to take steps to prevent the withdrawal of coins from circulation.

The formation of the National Mining Corporation realizes the ambition of many a member of the London mining circles, in that it makes possible the handling of enormous low-grade or complex ore deposits in an efficient manner. No single mining house has hitherto felt able to finance the development of such properties as Chuquicamata or Braden in Chile, and it was obvious that only by some combination of effort could the big business be possible. A glance at the history of some of the largest mining operations is sufficient to show the desirability of having ample capital at the beginning. The Arizona Copper Co. had a long fight in the early days; Tanganyika and Burma Mines are current examples. As regards the formation of the National Mining Corporation, it must have been extremely difficult to arrange terms for such a combination that would be satisfactory to the many rival interests, and it will clearly be no easy matter to steer the newly-constituted team without hitch. But Mr. F. W. Baker has been successful in bringing the scheme to fruition, and he is quite equal to any future responsibility. He will be the first managing director, and with him will be associated Mr. B. Kitzinger, lately one of the managing directors of Consolidated Mines Selection. Mr. Herbert Guedalla is chairman, and the other directors are: Messrs. J. A. Agnew, A. Stanley Elmore, Henry Steel (of Doncaster, chairman of United Steel Companies, Ltd.), Stanley Christopherson (Consolidated Gold Fields), F. A. Govett (Lake View & Oroya Exploration), Walter McDermott (Consolidated Mines Selection), Henry Strakosch (Union Corporation), and E. Mackay Edgar (Sperling & Co). The capital is £3,000,000, of which £2,000,000 was subscribed before the issue of the prospectus, while the £500,000 offered to the public was considerably over-subscribed.

The nominal capital of Minerals Separation, Ltd., has been increased from £50,000 to £500,000, and 50,000 new shares of £1 each are being offered at £2 to shareholders. The company reports a great access of new business, and announces its intention of handling ore deposits for itself. In particular a copper deposit in Spain is mentioned.

Transvaal.—The ability of the producers to realize their gold in the highest market is having a good effect, and the outlook is cheerful. The labour shortage continues, as may be seen by the statistical figures given in the tables on another page.

Springs Mines reports that during the quarter ended September 30 the development totalled 4,555 ft., of which 3,235 ft. was on the reef. The percentage of payable ore was 71·9% and the assay-value averaged 25·1 dwt. over 20 inches. No. 3 shaft was sunk 584 ft. during the quarter, the depth being 2,046 ft.; it is expected to reach the reef at 3,400 ft. The sinking of No. 4 shaft will be commenced when No. 3 is completed.

The quarterly report of the Brakpan to September 30 shows that 3,715 ft. of development was done on the reef, of which 2,205 ft. averaged 12·88 dwt. over 40 inches, the proportion of payable reef being 60%. No. 3 circular shaft was sunk 565 ft., to a depth of 1,801 ft., and No. 4 circular shaft was sunk 481 ft., to a depth of 2,334 ft. In the sinking of the new shafts at Brakpan, Springs, and West Springs, particular attention is given to other auriferous reefs encountered, these belonging to the Kimberley series; but the sampling in all cases has indicated far too low a grade to warrant further consideration.

It is reported that the General Mining & Finance Corporation, otherwise the Albu group, has acquired options on the mineral rights of the Pretoria lead-zinc-copper district. These deposits were in former years worked by the Transvaal Silver Mines and other companies, but the complexity of the ores and the absence of railway communications combined to make the enterprise a failure. The argentiferous galena is associated with pyrite, chalcopyrite, and tetrahedrite, in a gangue of siderite. In this connection it is of interest to record that the Union Government has recently published a pamphlet on the base-metal resources of South Africa, written by Mr. W. Versfeld, and that Mr. T. G. Trevor, one of the Inspectors of Mines, has come to this country with the object of arousing interest in this class of deposit.

It is announced that the German diamond fields in South-West Africa have been purchased for £3,500,000 by the Anglo-American Corporation of South Africa, the company which operates in the Far East Rand in association with Consolidated Mines Selection. The negotiations were conducted on behalf of the corporation by one of the directors, Mr. H. C. Hull, who previously was Minister of Finance for the Union of South Africa. A company called the Consolidated Diamond Mines of South-West Africa is to be registered at Cape Town to take over the property.

Rhodesia.—The par value of the output of gold during September was £223,719, as compared with £207,339 in August, and £247,[illegible] in September last year. Some of the mines, notably Rezende, have been suffering recently from a return of the influenza. Other outputs for September in Southern Rhodesia were: Silver 13,632 oz., coal 43,139 tons, chrome ore 1,816 tons, copper 253 tons, asbestos 934 tons, arsenic 18 tons, diamonds 31 carats.

At the Shamva mine, 556,881 tons of ore averaging 3·63 dwt. per ton was milled during 1918, yielding gold worth £383,843, for a profit of £111,844, and £120,000 was distributed as dividend, being at the rate of 20%. Development and prospecting operations gave excellent results, and disclosed 971,200 tons averaging 3·8 dwt., making the reserve at December 31, 1918, 2,023,000 tons averaging 4·3 dwt. A couple of years ago there was good ground for fear that the limit of the ore deposits had been reached, so the subsequent success of the lateral exploration is particularly gratifying.

The participation of the Central Mining and Investment Corporation in the Rhodesia Broken Hill Company is indicated by the election to the board of Sir Harry Ross Skinner and Mr. T. J. Milner.

For some time it has been known that the limits of the rich ore at Globe & Phœnix have been reached and that the company has been drawing on the reserves in order to maintain the output. This was clearly shown in the report for 1918, referred to in the Magazine for May. The company last month issued a revised estimate of the reserve. The figures are now 143,333 tons averaging just under 30 dwt. per ton, as compared with 159,913 tons averaging 29·4 dwt. at the end of 1918, and 184,053 tons averaging 28·9 dwt. at the end of 1917. In the past some parts of the mine have yielded more ore in mining than had been indicated by the estimate of reserves. The directors state that no such excess can be expected in the future. A large proportion of the reserve is in pillars and cannot be mined at once, so that the monthly output has been reduced from 6,500 tons to 5,000 tons. In the meantime a vigorous campaign of exploration and development has been commenced. The directors state that the present rate of output is unlikely to provide any surplus out of which dividends can be paid for some time unless a new ore-body is struck. An announcement of this sort in connection with a mine carrying so much high-grade ore surely requires some amplification.

The Minerals Separation plant at Bwana M'Kubwa started on September 23. This plant is notable as it is treating oxidized copper ores. The trial run from September 23 to 30 treated 480 tons of ore yielding concentrate averaging [illegible] copper, the recovery being 76·4%. In the second trial run, from October 1 to 7, 471 tons of ore gave concentrate averaging 26·7% copper, the recovery being 75%. The continuous run commenced on October 14, and from then to the 19th, 479 tons gave 86 tons of concentrate averaging 26% copper, the recovery being 80%. In the report of the two trial runs no note is given of the assay-value of the ore treated or of the amount of concentrate produced. In the report of the run from October 14 to 19, the tonnage of the concentrate is given, and from this it is possible to deduce that the assay-value of the ore treated was 5·8%.

West Africa.—The output of gold during September was reported at £100,401, as compared with £103,112 in August and £115,152 in September of last year. The Abosso did not maintain the increase in the grade of the ore treated, which was a feature of the August output.

The report of the Abbontiakoon mine for 1918 shows 106,014 tons were milled for a yield of £208,749, against a working cost of £200,825. From January 1 to September 30 of the current year, 69,005 tons yielded £133,199 at a cost of £132,171. The payable ore reserve at the end of 1918 was 391,163 tons averaging 10·55 dwt. The developments in the lower levels of the Main reef are not encouraging, but the West reef is giving better results, though there are long stretches of unpayable ground.

The property of the Wassau Mining Company has been finally closed, as the tributers who started work a year ago have ceased operations.

The New Lafon Tin Fields sold its property in August to the newly-formed Associated Nigerian Tin Mines, Ltd., as recorded in this column at the time, the purchase price being £97,000 in shares in the latter company. The Lafon has issued its report for the year ended September 30, showing that, during the 10 months until the sale of the property, the output of tin concentrate was 237 tons, as compared with 151 tons during the previous 12 months. The profit was £7,989, out of which £7,348 is being distributed as dividend, being at the rate of 20%.

Australasia.—The strike at Broken Hill continues. Our Melbourne correspondent gives some account of the vicissitudes of the smaller producers of the base metals, such as lead and tin, particularly in West Australia. Since this letter was received, we have been informed that the West Australian Government is not in favour of the establishment of a State smelter, but points to the Fremantle smelter as affording all the smelting accommodation required. This smelter is, however, closed down, as our readers are aware, owing to the conditions to which the deputation mentioned by our correspondent referred. Whether the West Australian Government intends to give assistance to the reopening of these works or not is not clear.

Operations at Kalgoorlie are interrupted once more by labour troubles. The present cause of dissatisfaction arises between members of the two unions and also between union and non-union men. Cables announce that all the mines have stopped work.

The report of Broken Hill South covers the year ended June 30 last, but work ceased on April 30 owing to the strike. Previous to the latter date, there were many interruptions, and shortage of suitable labour also curtailed output. Thus it happened that during the year the ore raised was only 164,875 tons, as compared with 127,745 tons during the six months ended June 30, 1918. The working profit was £344,122, out of which £90,000 was placed to new-plant account, £37,500 was written off for mine development, £32,500 was paid as tax and royalty, £120,000 was distributed as dividend, and £64,112 was carried forward. As already recorded, a fire occurred on July 30 at the Main shaft. The ore reserve was maintained at the same figure as the year before, 3,500,000 tons.

With regard to the participation of the Imperial Government in the Commonwealth's scheme for boring for oil in Papua, it is now announced that the Imperial Government is providing £50,000 and controls the selection of the boring parties.

India.—The hydro-electric installation at the Cauvery Falls is to be extended, and the horse-power brought up from 21,000 to 30,600. Additional power is required at the Kolar gold mines, and current is also being supplied in increasing quantities to the cities of Bangalore and Mysore for power and lighting purposes. As readers are aware, the Cauvery Falls scheme was inaugurated early in this century for the specific purpose of supplying power to the gold mines of the John Taylor group, and the Mysore Government preferred to be the responsible party in control rather than let the gold-mining companies undertake the work.

Malay.—The Pengkalen, one of the Wickett group operating in Perak, has recently acquired a new area of tin-dredging ground. Of the total area 200 acres has been proved, of which 97 acres averages 0·55 lb. per yard and 103 acres 1·1 lb. per yard. The average depth is 55 ft. The plan is to dredge 75,000 yd. per month, at which rate the property will last 16½ years.

Siam.—The Renong Tin Dredging Co., which was the pioneer of English bucket-dredging enterprises in connection with Eastern tin deposits, announces that the best parts of the ground will be exhausted before long. The remainder of the property is of problematical value, and continuation of operations will depend on results obtained. The company has recently examined a new property in Selangor, Federated Malay States, extending over about 1,200 acres. The borings on 400 acres are giving good results, and the option will shortly be exercised, while two other blocks of similar areas and of considerable promise are on offer to the company.

Cornwall.—The accident at Levant was the worst disaster yet experienced at an English non-ferrous metal mine since the flooding of East Wheal Rose in 1846. Our Camborne correspondent refers to the matter at some length, so that nothing further need be said here ; though it is desirable to remind readers that serious accidents also occur with the most up-to-date winding appliances, and that, in any case, the blame for the delay in reorganizing the mining methods at Levant does not rest on the management but with the owners of the mineral rights.

The directors of Tehidy Minerals, in announcing the allotment of the 40,000 shares offered at the end of August, state that they will not adopt the system of granting leases on a royalty basis, as has hitherto been the custom in Cornwall among the owners of mineral rights, but instead will encourage the formation of subsidiary companies in which Tehidy Minerals will retain substantial interests. The company is losing no time in connection with the study of the china-clay resources of the Clifden estate, and Dr. Malcolm Maclaren has the matter already in hand.

The Killifreth mine has been unwatered to the 40 fm. level on the North lode and the 50 fm. level in the Middle lode. About 400 samples have been taken on the old stopes, and 2,000 tons of ore averaging 50 lb. of black tin per ton has been thereby proved. At the bottom of a winze below the 30 fm. level on the Middle lode the ore averages 350 lb. of tin and wolfram per ton over 18 inches. In some of the old pillars left by previous workers on the Middle lode the ore is extremely rich. These pillars are only of small extent, but they provide much encouragement to those interested in the reopening of the old mine.

The report of Geevor Tin Mines for the year ended March 31 shows that 25,919 tons of ore yielded 439 tons of tin concentrate and that the profit was £17,854. Dividends absorbing £12,000 have already been distributed, and £13,730 of debentures have been redeemed. In order to provide funds for additional development and plant, it is proposed to issue 180,000 new 10s. shares at 15s. each. The meeting of shareholders will not be held until after the publication of this issue of the Magazine, so we postpone further reference.

British Oil.—The Petroleum Executive on Oil-Boring Operations has issued a report bringing information up to the end of September. From this it appears that the Hardstoft bore in Derbyshire had been producing oil for between four and five months. The total production was 897 barrels, and the daily flow about 8 barrels. The pumping plant is not yet in proper order. Ironville Nos. 1 and 2 and Ridgeway, also in Derbyshire, had passed the horizon at which oil was tapped at Hardstoft, without meeting more than slight traces of oil. The other six Derbyshire wells had not yet reached this horizon. In Staffordshire, the Apedale bore was down 1,350 ft., in the Coal Measures, and the Werrington was down 1,175 ft. in Carboniferous Limestone shales. In Scotland, the West Calder bore was down 780 ft., in the oil-shale series. A slight trace of oil was found in a 10 ft. sand, but this was of little importance. The D'Arcy bore was just being commenced. It is also stated that little is now being done at the other Derbyshire bores owing to the difficulty of obtaining linings and other apparatus.

Canada.—The Nickel Plate gold mine, in the Boundary district, British Columbia, has been closed down owing to high costs. This mine is operated by the Hedley Gold Mining Co. It is the second biggest gold mine in the Province, the Surf Inlet having out-distanced it a year or more ago. In speaking of "gold mines" we do not include the copper-gold mines, which are as a matter of fact larger gold producers than the mines worked for gold only. The ore at the Nickel Plate mine is highly arsenical, and is first cyanided and then concentrated. The capacity of the plant is 200 tons per day, and the yearly yield is about $800,000, so it will be seen that the ore is of low grade. In normal times excellent profits have been made, but the recent rise in costs has wiped out the margin.

Mexico.—The El Oro Mining & Railway Co. announces that the profit for the year ended June 30 was in the neighbourhood of £69,000. A dividend at the rate of 5% was paid on October 31, absorbing £57,375. The annual report of Mr. A. F. Main, the manager, has not yet been received, but should come to hand this month. The directors' report will then be issued, and the shareholders' meeting will follow early in December.

Colombia.—In August, 1918, we gave some account of the properties of the British Platinum & Gold Corporation, in the Choco district, for which a dredge has been built to the designs of Messrs. Inder, Henderson, & Dixon. It is now announced that Mr. T. J. Ive, the managing director, who is at present in Colombia, has acquired for the company some additional properties. The agreement gives control to the company of all the platinum and gold properties owned by Messrs. Pugliese, Frigerio, & Mayolo. One of these properties is suitable for dredging forthwith, 5,000,000 cubic yards averaging 2s. per yard having been proved, and orders for a dredge to work it have already been given by the company. The deal involves no payment in cash, but the local firm will be paid on a profit-sharing arrangement. Mr. Mayolo will join the board.

The Nechie Consolidated Gold Mining Co., Ltd., has been formed with a capital of £500,000 to acquire alluvial gold ground in the Nechi River district, and Mr. E. A. Lang has left London to make the necessary examinations by boring. The company must not be confused with the Nechi (Colombia); it does not belong to the same group.

Russia.—The companies belonging to the Urquhart group, namely, the Kyshtim, Tanalyk, Irtysh, and Russo-Canadian Corporations, are to be amalgamated for the purpose of strengthening their position. The details of the scheme are not yet settled.

THE TIN DISCOVERY IN WEST AFRICA.

By D. J. MacDONALD, M.Inst.M.M.

The author gives details of the tin lodes at Mankwadi, near Winnebah.

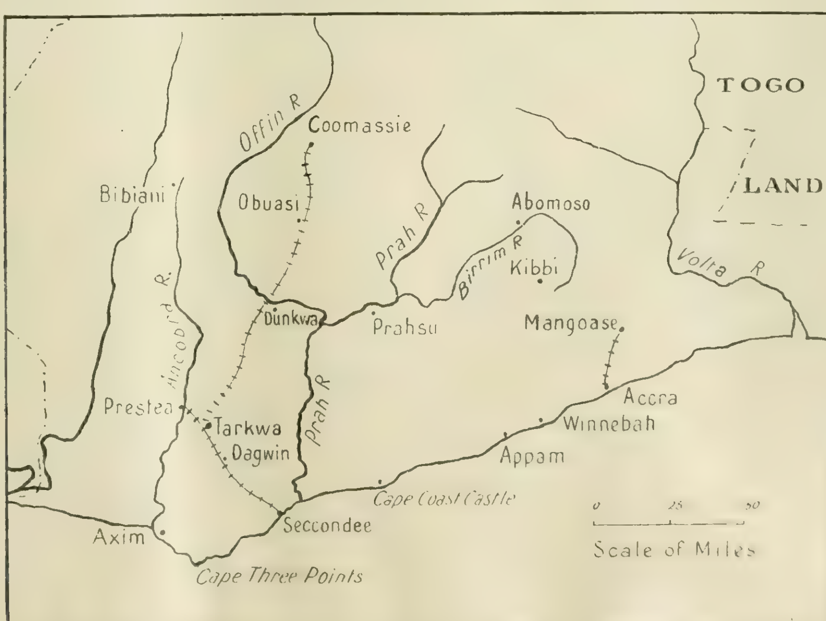
IN the Magazine for May a brief summary was given of the report on the Winnebah tin deposits, West Africa, made by my firm, Innes, MacDonald, & Seale. The present article has been written by me from the notes of the late Mr. A. C. E. Seale, who had been in charge of the prospecting work during the last six months of his life.

The existence of a deposit of high-grade coarse alluvial cassiterite was proved by a private syndicate four years ago in the bed of a stream flowing into a salt-water lagoon on the sea coast about five miles west of the port of Winnebah. The nearest village to the deposit went by the name of Mankwadi, which has given its name to the find. Some work was done at the time in the way of trenching and pitting with the objects of, firstly, proving the extent of the alluvial deposit, and, secondly, finding the source of the cassiterite in the wash, which, being in many cases scarcely water-worn, did not appear to have travelled far from its point of origin.

These early operations failed to prove anything of much consequence beyond the fact that the country was a hornblende schist highly garnetiferous, striking in a N.E. and S.W. direction and intersected by dykes of various kinds, mostly coarse-grained pegmatites running in a general N.60°E. direction. It was evident that some of these dykes were the original ones in which the cassiterite had been deposited; but, unfortunately, those outcrops which were exposed and accessible at the time carried extremely small quantities of the mineral.

The area covered by the tin-bearing gravel was found to be limited to the creek bed, which was about 150 ft. wide where it entered the lagoon. The lagoon itself, although it could never be tested properly owing to the amount of water, yielded fair prospects of fine grained cassiterite. A small quartz vein carrying molybdenite was found about a mile to the west of the original workings, but this was not opened out at the time.

The outbreak of the war put a stop to the operations, until they were renewed in 1918 under circumstances more favourable to the obtaining of reliable results. Some tons of high-grade cassiterite were won from the creek bed and shipped to England, and during the time



MAP OF WEST AFRICA, SHOWING POSITION OF WINNEBAH.

this work was in progress, prospecting was vigorously carried on in the neighbourhood. The first result of this prospecting work was the discovery of a dyke or vein of quartzite running in a similar direction to the other dykes, but carrying a complex mixture of arsenical iron pyrite, gold, molybdenite, and a highly argentiferous galena. A little work was done on this, and, although at first the ore was of a high grade, later results were not sufficiently encouraging to make it worth while continuing work at that stage. It should be mentioned that, in panning and calabashing the tin-bearing gravel, gold is found in the dish in every case, so much so, that the native washers invariably carry a small bottle in which to put the grains of precious metal collected during the day's work. The task of locating the tin-bearing pegmatites was at last rewarded by the discovery of some specimens of float pegmatite very rich in cassiterite, quite close to the alluvial workings.

The country, although open, is covered with thick grass, and in many cases, especially on the hill-sides, with a low dense scrub which grows to such a thickness as to make it impenetrable. It is necessary to cut and burn it before anything of the surface soil or float rocks can be seen. One of the first outcrops discovered by trenching, at a few feet below the surface, gave such good results on being opened out both as regards values and width that it appeared as though it might turn out to be something out of the common. Further work, however, showed that what appeared at first to be a lode over 100 ft. wide was more in the nature of a sill or large overflowed cap to one or more dykes. Two of these dykes are now being sunk upon, and they are going down so strongly as to lead to the expectation that they are feeders to the capping. As the concession is being cleared and examined, more dykes, not always parallel in direction, are being found and opened out, and many of them carry tin in payable quantities. So far, four groups have been found and continuous outcrops have been traced for as much as ¾ mile and up to 30 ft. in width.

The area over which these finds have been made has a considerable width measured across the strike of the schist country, and up to the present no limit has been found to the area, either along or across the strike. Quite recently cassiterite has been found in similar dykes as far as 20 miles west of the original discovery. The dykes occur both on the flats, where they are often covered by alluvial soil, and on the slopes and tops of the hills up to a height of 400 ft. above the surrounding level.

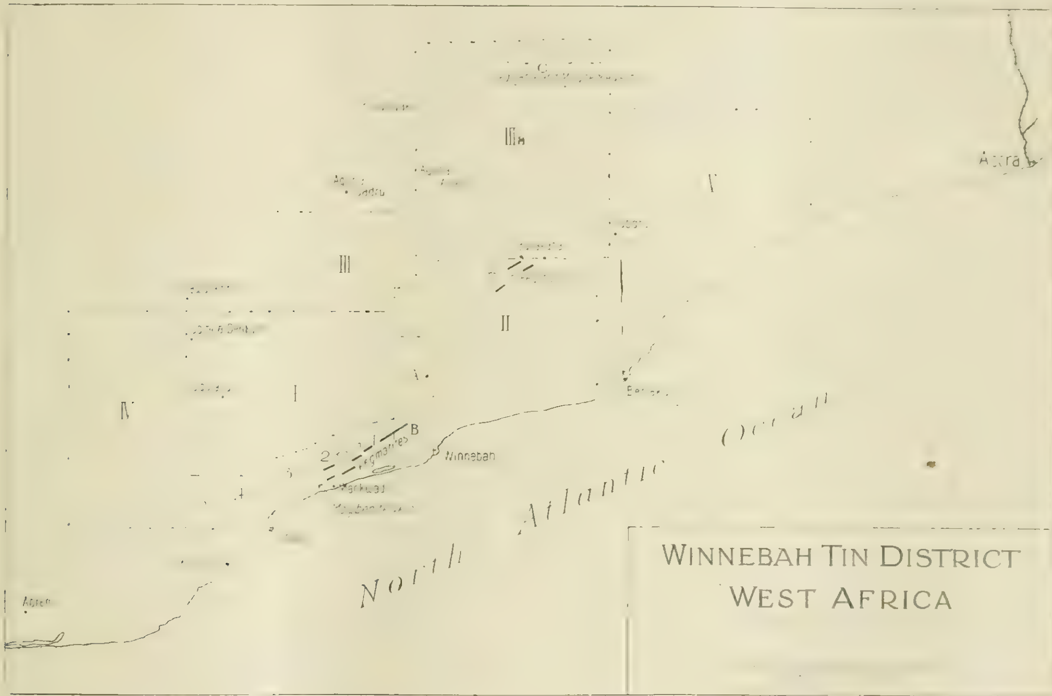
The belt of country through which the granite, pegmatite, and other outcrops of a similar character have been intruded, appears to be a hornblende schist carrying a large quantity of garnets, striking roughly N.E. and S.W. and dipping steeply to the S.E. On the S.E. large masses of granitoid rocks outcrop near Winnebah, and these probably underlie the schists at a depth at present unknown. The same country has been observed to the S.E. of Kibbi, about 60 miles inland from Accra, and, in the opinion of the Government Geologist, continues in a N.E. direction to the Volta river, and so through into Togoland, while to the S.W. it appears on the sea coast in the neighbourhood of Cape Coast Castle. It is bounded on the N.W. by the ranges of altered sedimentary and igneous rocks, sandstones, slates, diorite, and dolerites forming the Kibbi hills. The width of this belt would appear to be from 20 to 30 miles, but outcrops and intrusions of the granite occur at many points in this area.

These pegmatites are of all classes, from entirely acid quartz veins to entirely basic felspars. The associated minerals are many, including cassiterite, scheelite, gold, molybdenite, galena, hornblende, tourmaline, and arsenical pyrites. The felspars are of various kinds, and with them are associated quartz, kyanite, apatite, and mica. The appearance of the pegmatites varies from finely crystalline to porphyritic, and although they present many combinations of the above minerals, there has not been found, so far, any combination which particularly favours the occurrence of cassiterite. The only exception to this is the case of tourmaline which is always present with cassiterite. The tourmaline is of several varieties and colours, and occurs in many forms, from acicular crystals up to 1½ inches in diameter and several inches in length, to microlites disseminated evenly through the mass of felspar. The same remarks apply to the crystals of cassiterite, which appear, in many cases, to have taken the form of the associated tourmaline, so much so, that the two are exceedingly difficult to distinguish one from the other.

So little work has been done up to the present that an expression of opinion as to the origin of the pegmatites is rather hazardous. The dykes would appear to have their origin in the granite which underlies the schist country in which they occur, and which outcrops largely on the S.E. boundary of this belt at Winnebah and Appam, and there is no reason to suppose that those dykes which are tin-bearing at or near the surface do not carry this mineral down to their point of origin. There is no evidence up to the present by which to determine the depth at which the granite occurs, but this will be found to vary from point to point in the area under consideration. It may happen that the granite itself will be found to carry cassiterite, which may also have developed in payable quantities at or near the junction of the two classes of rocks.

In the same stretch of hornblende-schist country and about 50 miles N.E. of Mankwadi, where the original deposit of tin was found, country in which the tin-bearing pegmatites outcrop. When one takes into consideration the number and variety of minerals which have been found in this district and the existence of nickel and copper ores in the vicinity, it seems evident that future developments in this, the latest of tinfields, will prove extremely interesting and worthy of attention.

The map on this page shows the areas acquired by various operators. (*I.*) represents the option held by the Appollonia Goldfields, Ltd., and Messrs. F. & A. Swanzy, Ltd. Within this option (*1*), (*2*), (*3*), (*4*), and (*5*) are the

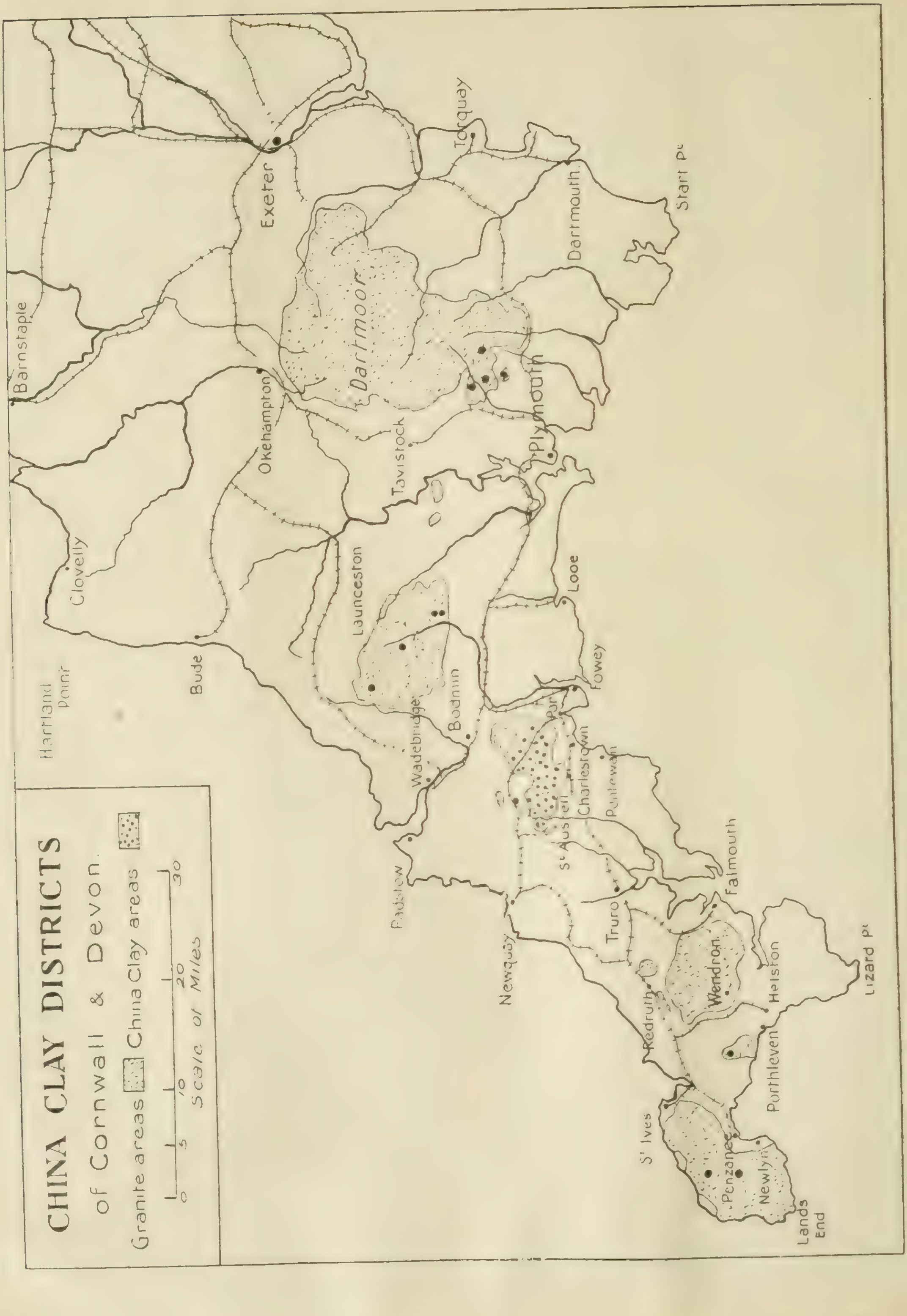


WINNEBAH TIN DISTRICT
WEST AFRICA

the Birrim river has its rise, and from here runs for some miles in a northerly direction. It then turns to the west around the north-east corner of the Kibbi range of hills and continues flowing in a wide alluvial valley, covered with gravel, in a south-westerly direction to its junction with the Prah. It is in this latter valley, and not far north-west from Kibbi, that diamonds have lately been found by the Government Geologist, Mr. A. E. Kitson, during a prospecting tour in which he was engaged. Should it be discovered later that the gravel deposit in which these diamonds have been found is the result of the weathering of the country in which the Birrim takes its rise, it opens out the possibility of diamonds being found to occur anywhere in the same belt of

leases taken up by these companies, and now being examined by the Ashanti Goldfields Corporation. (*II.*) is the option held by the Dunkwa Mining Syndicate, and the London Dublin Gold Coast Syndicate; (*A*) being the Bewade lease and (*B*) the Muni lease taken up by these companies. (*III.*) and (*III.a*) are options held by a local syndicate, and (*C*) is the lease taken up. (*IV.*) and (*V.*) are options held by two companies whose names are withheld by request.

Our leading scientific paper *Nature* celebrated its jubilee with the issue of November 6, which contains many instructive reviews of progress during the past half-century, written by many eminent leaders of thought.


CHINA CLAY DISTRICTS
of Cornwall & Devon.
Granite areas
China Clay areas
0 5 10 20 30
Scale of Miles
Exeter
Torquay
Dartmouth
Start Pt
Dartmoor
Barnstaple
Okehampton
Tavistock
Plymouth
Clovelly
Launceston
Looe
Bude
Hartland Point
Bodmin
Wadebridge
Fowey
Par
Charlestown
Pentewan
St Austell
Padstow
Falmouth
Truro
Newquay
Wendron
Helston
Lizard Pt
Redruth
Porthleven
St Ives
Penzance
Newlyn
Lands End

THE CHINA CLAY INDUSTRY OF THE WEST OF ENGLAND.

By HENRY F. COLLINS, A.R.S.M., Assoc.M.Inst.C.E., M.Inst.M.M.

China Clay is one of the most important mineral products of the United Kingdom. The author describes its geological occurrence and mineralogical characteristics, the method of mining and preparation for market, and the economic questions involved in its disposal.

CHINA clay is, after coal, the most important of the limited list of raw materials that the United Kingdom can export. In view, therefore, of our economic position, with heavy bills to be paid for imports, it is of the highest importance to develop to the utmost the export trade in this mineral, with a view to reducing the trade balance against this country.

The geographical distribution of the principal deposits of china clay in the West of England is shown upon the accompanying map, which also shows the principal shipping ports for china clay, and the railways, except small branch lines, serving only the clay-works, for which the scale is too small. Taking the granite areas in order, beginning at the east, the Dartmoor granite shows china clay at only a few places; the granite area north of Bodmin too is only just beginning to be worked at three or four places. Most of the output of the china clay comes from the Hensbarrow district north of St. Austell, a large proportion of which is covered by clay deposits. Nothing has as yet been found in the Wendron area, and only two works each are at present producing in the Tregoning Hill area north-west of Porthleven, and the Land's End area.

NATURE AND COMPOSITION OF CHINA CLAY.—China clay is a white, very fine powder which, when kneaded with water, forms a paste much whiter than common ball, or pipe-clays, though less plastic and tenacious than these. When dried, the paste cakes into lumps of little coherence but of uniformly smooth and soft texture, free from even the smallest grittiness, although powdery rather than greasy to the touch. In this form it is put upon the market.

From the point of view of the chemist, china clay, or kaolin, is a hydrated silicate of alumina; more technically its composition may be described as corresponding roughly with that of an alumino-disilicic acid. Analysis of the purest commercial samples, however, does not agree at all closely with the supposed theoretical formula, Al_2O_3, $2SiO_2$, $2H_2O$, which calls for 46·77% SiO_2, 36·9% Al_2O_3, and 16·4% of combined water, for the purest china clays in their ordinary commercially dry condition vary between 11 and 13·6% of combined water. When dried *in vacuo* over sulphuric acid, the content of combined water is reduced uniformly to about 10·5%*, for which and other reasons the late Mr. J. H. Collins suggested the formula $3H_2O$, $2Al_2O_3$, $4SiO_2$ as being more in accordance with the actual composition.

The following analyses show the extreme variations in composition among commercial samples of china clay of the best quality from different works, all dried at 110°C.

	1	2	3	4	5	6
	%	%	%	%	%	%
SiO_2 (and traces of TiO_2)	47·23	46·2	45·4	48·38	37·24	46·69
Al_2O_3	39·49	41·1	40·3	36·99	50·56	38·34
Fe_2O_3	0·23	0·1	0·2	0·62	0·61	0·45
CaO	0·31	tr	tr	0·15	0·20	0·33
MgO	0·24	0·2	tr	tr	tr	0·10
Alkalies	0·21	0·4	0·6	0·29	0·18	1·42
Water	12·24	12·5	13·5	13·57	10·21	12·56
	99·91	100·5	100·0	100·0	100·0	100·0

The composition of sample 6 may be looked upon as abnormal, being low in silica and high in alumina; it probably contains some allophane.

ORIGIN.—From the point of view of the geologist, china clay is a product of the decomposition *in situ* of the felspar constituent of granitic rocks, by means of the circulation of acid solutions proceeding from below. In order to separate it from the other constituents of the granite (mainly quartz and mica, with more or less tourmaline), the china clay has to be washed out with a stream of water, from which it is recovered by settling.

Some geologists have assumed that the decomposition has been the result of atmospheric agencies. Others have supposed that humic and other vegetable acids, proceeding from peaty surface growths, have contributed toward the decomposition of the granite. The extremely local character and limited distribution of the decomposition is sufficient to demonstrate that both these hypotheses are totally inadequate and untenable. Others again have assumed, for no sufficient reason, that it is only certain intrusions of newer granite that have been affected by the phenomena of decomposition. Close investigation into the china-clay deposits of the West of England shows that

* See *Mineralogical Magazine*, Vol. VII, [illegible], p. [illegible]

the occurrences of china-clay rock are *invariably* associated closely with groups of small fissure veins, from which fact it is only reasonable to deduce that the origin of the decomposition is attributable to the solutions or vapours that have found their way up through these channels. As to the agency by which

FIG. 1. GENERAL VIEW OF A LARGE SHALLOW CLAY-PIT
(Photo, English China Clays, Ltd., St Austell)

decomposition has been effected, it is to be noted that the process of kaolinization, that is, the change from felspar into kaolin or china clay, involves a gain of water and a loss of alkali and of silica. The agent was therefore doubtless an acid of some sort, possibly carbonic, possibly sulphuric. Experimentally, the kaolinization of felspar or felspathic rocks has been effected by both of these agents; sulphuric acid in particular appears to have been in many cases the active agent in bringing about kaolinization in mineral veins where kaolin is found associated with pyrites. In Cornwall and Devon, however, the total absence from the china-clay pits of all carbonate and sulphate minerals, and the *intimate* and *invariable* association of kaolin with minerals like tourmaline, gilbertite, and more rarely topaz, all of which contain fluorine, would appear to indicate that hydrofluoric acid probably played a prominent part in the kaolinization of the granite of this field. The late Mr. J. H. Collins indeed actually produced kaolin, indistinguishable in its composition and properties from that found in nature, by exposing orthoclase felspar under a bell-glass during a long period to the action of the vapours from very dilute hydrofluoric acid at ordinary temperatures; the same effect was produced more rapidly by immersing the felspar in the acid.

MODE OF OCCURRENCE. The decomposed granite known as "china-clay rock," or "clay-ground," although in exceptional cases so hard as to need blasting before it can be sufficiently broken up for washing out the clay, is generally soft; frequently indeed so soft as to be easily cut out by a spade, becoming in wet weather of almost putty-like consistency. The proportion of clay to "sand" (under which name are included the other mineral constituents of the rock, principally quartz, black tourmaline, and white mica) varies ordinarily from 12% up to 30%. In rare cases the proportion of clay in the ground runs up to 40 or 50% or even more; a fair average of the ground now being worked over the whole district would be between 20 and 25% of clay. These variations are due in part to differences in the proportion of felspar in the original rock, in part to the fact that frequently only a portion of the felspar has been decomposed, namely, the finer-grained portion, including the plagioclase (usually albite); the large porphyritic crystals of orthoclase, when present, appear to have very generally resisted decomposition much more than the smaller crystals that form part of the rock base.

[1] *Mineralogical Magazine*, 1886, Vol. VII, p. 213.

The deposits or "beds" of clay-ground generally show in plan a much elongated form; frequently indeed their length is very small in proportion to their width. They frequently affect the form of "dykes" and are always closely associated with leaders or veins composed of quartz with "schorl" (black tourmaline) and sometimes traces of tin oxide, that traverse the deposits. The greatest extension of the decomposed clay-ground coincides with the bearing of the veins, in which direction, indeed, kaolinization may extend for half a mile or more, while it rarely extends to more than a few fathoms on either side of the schorlaceous veins from which the solutions that affected the decomposition appear to have been distributed. When clay-ground is found to extend over a wide area, therefore, it is invariably traversed by a group of parallel veinlets, or sometimes by two systems of veins crossing each other at a high angle, each of which has affected the country on either hand. It is by no means, however, the most important quartz veins that give rise to the most wide-spread alteration of the granite; it was noted 40 years ago that "the breadth of the decomposition does not seem to bear any relation to the size of the vein." *

Fig. 2. Another View of Pit shown in Fig. 1.
(Photo, English China Clays, Ltd., St. Austell.)

A large proportion of the clay deposits, particularly those which are most extensive, are marked by shallow depressions in the granite, some of which form marshy places. Many of the principal valleys upon the high moors, and of the secondary valleys on the lower ground, follow lines which correspond with a linking up of these depressions, and coincide roughly with the main directions of fissuring. Sometimes a series of clay deposits can be traced following almost exactly the strike of a group of mineral veins, and in such cases the relationship between the decomposition of the granite and the solutions that came up through the veins becomes evident. In vertical section the deposits may appear to be either dyke-shaped or basin-shaped, according as to whether they are associated with a single system of parallel veins, or with two groups crossing at an angle. Many of the former type have been followed down to considerable depths (250 to 300 ft.) without pinching or marked variation in horizontal section; some indeed have even increased in sectional area as followed downward. In rare instances basin-shaped deposits have apparently "cut out" upon a floor of hard granite; all such cases have been situated upon hill-sides, and may be looked up-

*Collins: "The Hensbarrow Granite District," Truro. 1878, p. 7.

on as owing their origin to the overflow of solutions from a fissure-channel into some bed of the granite that was either more permeable or more readily decomposed than that underlying. In one or two cases such a hard "floor" of almost undecomposed granite has been penetrated, and soft clay-ground again found beneath. No well-authenticated case can be cited of the cutting out of a true clay "pipe" or deposit situated, not upon a slope, but upon the high moorland or in one of its valleys.

Away from the veins, and toward the sides of the deposit, the soft china-clay rock gives place to hard granite, the change being often sudden. More frequently, however, the transition is gradual, so that a considerable thickness of rock is found of intermediate composition, which if washed as soon as exposed would yield little clay, but, after breaking down and weathering for some time, can be washed with a satisfactory yield. It is worth noting that the quality and colour of china clay from a given pit usually *improves* as depth is attained, although the yield often falls off, the ground becoming "leaner," that is, the proportion of sand to clay is greater.

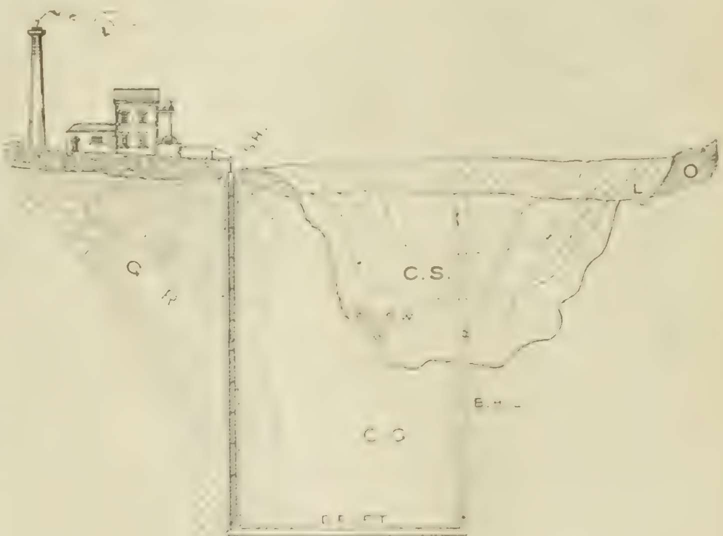


Fig. 3. Vertical Section of Typical China Clay Working.

The pits in which the ground is worked are always more or less basin-shaped or funnel-shaped, because they must be made wider at the top than at the bottom in order to prevent the sides from coming in, and also because the clay-ground is always overlain, under the surface soil, by a certain thickness of "overburden," consisting of loose earth and gravel with boulders of granite, and sometimes a bed of peat. Frequently, too, the upper part of the clay rock proper is so stained with iron oxide, either throughout or in myriad joints, as to be commercially valueless; in such cases it is considered to form part of the overburden. The total depth of these waste materials which have to be removed may vary from as little as 3 ft. to as much as 60 ft. When shallow, the overburden is always removed by hand-labour, using wooden tip-waggons holding about a ton, running upon tramrails. When deeper, a steam navvy is sometimes employed.

Method of Winning Clay.—The approximate extent of the deposit of clay (called locally "clay-bed"), is ascertained by a series of trial pits, supplemented in some cases by bore-holes put down in the bottom of some of the pits by means of a 3 in. auger and hand-gear.

The layout of the works will largely depend upon the extent of the clay bed and the configuration of the ground. If on a hill-side, or upon high land not too far from a deep valley, the most desirable way to open up the deposit is by means of an adit, below the mouth of which the settling and drying plant is situated. If sufficient fall is available the adit may be driven on a grade steep enough for the stream of water to carry out the sand together with the clay. If the fall is insufficient to admit of this, the adit is driven at such a grade as to take only the clay stream, leaving the sand to be raised from the pit by means of tram-waggons on an ordinary incline; New Lee Moor and Carclaze providing examples of this method.

In most cases sufficient fall is not available for an adit, except at ruinous expense, and preparations must be made for raising from the pits not only the waste sand and stony rubbish called "stent," but also the clay water (the aggregate weight of which is greater than that of the sand) by pumping. Two methods are in use. The first is shown in Fig. 3. A shaft is sunk into the solid rock, at some distance from one side of the clay deposit, to a depth of 30 or 40 fathoms. Leaving a convenient sump, a cross-cut is next driven from the shaft to below the point which is selected as the temporary bottom of the pit, and a rise is put up through the clay-ground to the surface, or to meet a winze put down part of the way from surface, after removing a sufficient area of the overburden. In the rise is fixed a "buttonhole launder" or box-pipe of rectangular section from 4 in. to 9 in. diameter, provided with large plug-holes in one side, closed temporarily by plugs or covers, through one or more of which at the top the clay stream enters so long as the bottom of the pit remains at a certain level, the others being opened in turn as the pit is deepened. The clay stream runs from the bottom of the launder back through the cross-cut to the shaft, where it is raised to surface, usually by a Cornish pumping engine with pitwork of from 12 in. to 15 in. diameter. Under this system of pumping, the sand has always to be raised from the pit separately, generally by means of hopper-skips running on steep inclines. In some cases Cornish pitwork is actuated through belts and gearing by suction-gas engines using anthracite.

In the second method, which is applicable only to comparatively new and therefore shallow pits, the clay stream is raised within the pit itself by means of centrifugal pumps. These are fixed near the bottom of the pit upon a heavy wooden bedframe, upon which is also erected the covering house, and which can be readily moved downward bodily as the pit is deepened. In order to obtain the maximum advantage of this form of layout, it is usual to employ gravel pumps capable of bringing up together with the clay the whole of the sand, and even small stones (say all less than $1\frac{1}{2}$ in. in diameter), leaving only the larger stones to be raised from the pit by means of tramwaggon and incline. The suction of the pump with the usual windbore or strainer is fixed inside a rectangular box or pen, with open top and bottom, composed of iron gratings with spaces of about 1 in. between the bars; assisted by a small nozzle under high pressure of water, the suction sinks its own sump as required. A common form of gravel pump for the purpose is of twin type. Two similar centrifugal pumps, but right and left hand respectively, are mounted upon the same shaft, with an electric motor between them to drive them both. One of the pumps is connected to the suction in the sump and delivers to the other, which thereupon forces the stream to the surface, the total head being perhaps 60 to 80 ft.

The gravel-pump plant is of course cheaper in first cost than the more ordinary type of plant with Cornish pitwork in a shaft, but, except from a small depth, and when working a "fat" clay deposit, it is much more expensive to work, both for power and for wear and tear. In the case of "lean" deposits, in which the proportion of sand to clay is as high as 6 to 1 up to 9 to 1, as well as in the case of deep pits, requiring several pumps in series, the maintenance and power cost of the system would soon become ruinous. In opening up a new pit, however, where the area to be worked is considerable, and more especially if the ground be "fat," with a ratio of clay to sand of not less than 1:3, the gravel-pump system is much more convenient, besides calling for a smaller capital expenditure.

The operation of breaking the clay-ground and washing out the clay from it may be carried out in two ways. In the older way a stream of water is conducted over the surface of the exposed clay in a so-called "stope" where, aided by men with chisel-pointed picks called "dubbers" and two-pronged hoes, it soon cuts out a gully called a "strake." Into this the sides are continually broken down, and the lumps which fall are disintegrated, in order to keep the average load of clay carried by the stream as heavy and as uniform as possible. In the more modern way of working, water under a pressure of from 50 to 100 lb. per square inch (obtained by gravity head in the case of deep pits, and by pumps in shallower ones) is discharged from a nozzle of $1\frac{1}{4}$ to $1\frac{1}{2}$ in. diameter at the bank of clay ground, exactly as in hydraulicking alluvial gold-bearing ground. The jet must be kept in constant motion in order to stir up and disintegrate the lumps rather than merely to bring them down.

With "fat" clay-ground it is easy to keep the clay stream at a content of 10 to 12% clay by the use of nozzles; when, however, the ground is lean and hard this becomes impossible even if the work of the nozzle itself is supplemented by much hand work in the strake, which therefore becomes necessary in order to keep the stream as thick as possible and so avoid extra cost of pumping. Another advantage of the method of washing in a strake is the facility it affords of picking out streaks and small pockets of discoloured ground which, if allowed to mix in with the rest, would spoil the colour of the clay, and therefore lower its quality for the market. Many producers of "best clays" therefore prefer to adhere to the old-fashioned method of hand washing, with its necessarily higher labour cost, on account of the facility afforded for washing "best" and "seconds" clays separately. Except therefore where the ground is very fat and uniform in quality, the nozzles have always to

FIG. 4. DOUBLE INCLINE AT THE BOTTOM OF A DEEP PIT WHICH IS BEING WORKED IN TWO STAGES.

(Photo, English China Clays, Ltd., St. Austell)

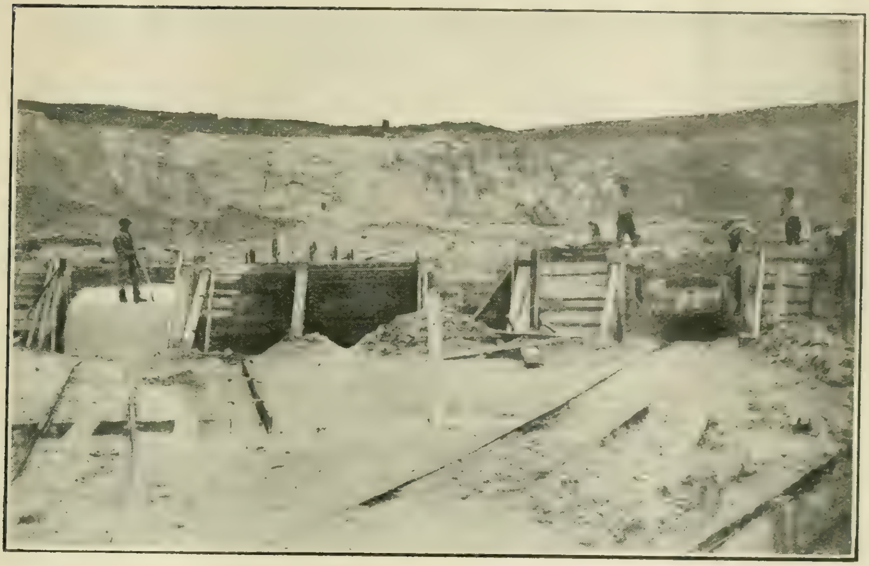


FIG. 5. DUPLICATE SAND-PIT, WITH SAND-WAGGON BEING FILLED WITH SAND FOR TRAMMING TO THE BOTTOM OF THE INCLINE.
(Photo, English China Clays, Ltd., St. Austell).

be supplemented by a certain amount of hand-labour.

Fig. 1 gives a general view of one of the largest shallow clay-pits. In the foreground three nozzles are seen at work breaking down the clay; in the background (centre) are two inclines for bringing up the sand.

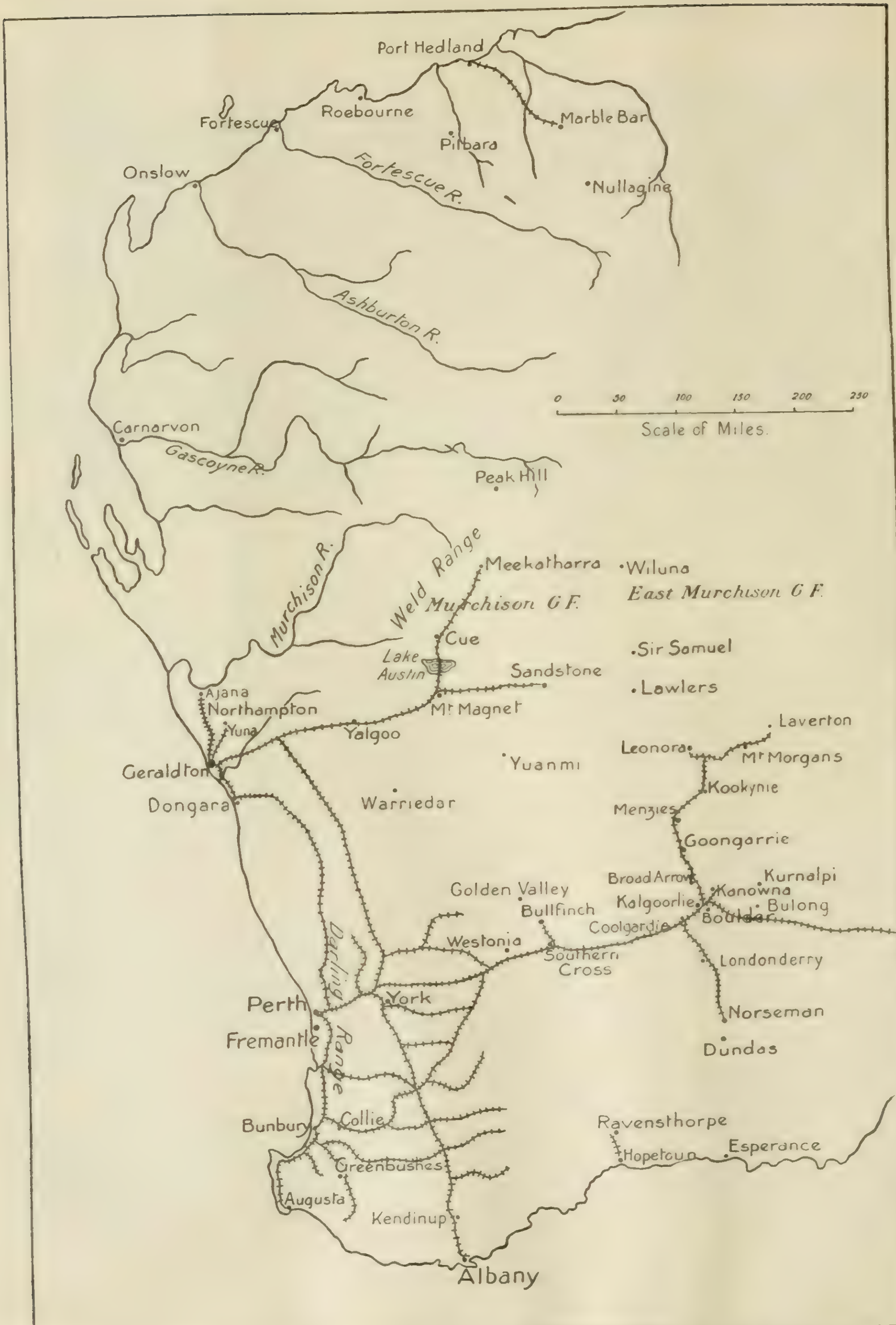
SEPARATION AND DISPOSAL OF SAND.—The stream carrying both sand and clay flows to the lowest point of the pit. If gravel pumps are employed, both sand and clay are raised together, a square box-grating with bars about 1 in. apart being placed round the suction of the pump to keep back all but the small stones.

The delivery of the pump is into large wooden boxes with hopper bottoms, in which the sand settles, while the clay stream overflows to the purifying and settling plant. Two boxes are generally used alternately, one filling while the other is emptied through a bottom door into trucks running upon an incline. Some form of valve discharge might perhaps be devised, but offers difficulties in view of the variations in size of the waste material between fine sand and coarse stones, and the necessity for avoiding loss of clay with the waste.

When gravel pumps are not employed, separation of sand from clay is effected at the bottom of the pit by means of shallow sand-pits, with fronts built up of slats, into which the stream is conducted, the sand settling, while the clay water overflows the slat front. These sand-pits are used alternately, and the sand from them is shovelled directly into the incline waggons or hopper-skip. The top of the incline may be either fixed or continually extending. In the former case the waggons are detached and run slightly downhill to the tip, or, if a hopper-skip is used, its contents automatically fill a waggon to be run off similarly by man power to the tip, which in such cases gradually attains a considerable horizontal extent. With the continually extending incline-top or "sky-tip," the whole headgear arrangement carrying the pulley is mounted upon a sliding framework of beams, provided with guys and counterweights, which is pushed forward as the dump itself advances. A hopper-bottomed skip with automatically actuated door is always used in this case, and the dump retains a conical form, increasing in height as it advances.

Fig. 2 is another view of the large pit shown in Fig. 1, with sand-pits, and waggons filled with sand being assembled near the bottom of the incline. Fig. 4 shows a double incline at the bottom of a deeper pit which is being worked in two stages; the sand-pits are shown in the centre foreground, to left and right respectively of the inclines. Fig. 5 shows details of the duplicate sand-pits, with sand waggon being filled with sand for tramming to the bottom of the incline.

(To be continued).



MAP OF WEST AUSTRALIA TO ILLUSTRATE THE HISTORY OF THE GOLD DISCOVERIES.

A HISTORY OF GOLD DISCOVERIES IN WEST AUSTRALIA.

By C. M. HARRIS, M.Inst.M.M.

This article may be read in conjunction with the author's paper on prospecting in West Australia, quotations from which are given in this issue.

The history of the mining industry of West Australia dates back to 1842, when Thomas Mason, a shepherd, discovered the rich lodes of copper and lead at Wanerenooka, at Northampton, situated 200 miles north of Perth. This and other mines in the district were worked for some years with considerable success by English companies, but little attention was given to prospecting for gold, until the rich discoveries in Victoria and New South Wales induced the Government in 1860 to employ Mr. Hargreaves (the discoverer of gold in the latter State) to report upon the prospect of finding gold-bearing reefs in what was then the Crown Colony of West Australia. The results of his inspection of the coastal areas were such that he gave it as his opinion that gold in payable quantities would not be found here. Small quartz leaders containing traces of gold with pyrite were found in the Darling Range and at Kendinup in the south-west. However, in 1883 Mr. E. F. Hardman, the then Government Geologist, discovered gold at Kimberley, which is the most northerly goldfield in the State. A rush of prospectors set in from the eastern States. A comparatively extensive area of surface alluvial deposits and some lodes were worked to a shallow depth, but the patchiness of the ore-bodies, together with the tropical climatic conditions, soon drove away the majority of these "othersiders," as they were termed. Then came a lull until 1887 when Mr. Glass discovered a small nugget of gold on his property at Mugakine, near York, but he was unable to find any more. This, however, gave an impetus to prospecting, and the Settlers Association, with the assistance of the Government, formed a party, with Anstey and Greaves as prospectors, to look for gold to the east of York. After travelling some 160 miles, they found several gold-bearing reefs, and called the spot Golden Valley. The result was that several more parties were equipped and sent out, one known as the "Phœnix" party, while at Golden Valley they were advised to go down to a line of hills due south. Owing to the heat of the day, and scarcity of water, they decided to travel by night, taking their direction by the Southern Cross. In doing so, they discovered the first large goldfield in West Australia, and named the centre after the constellation by which they found it. The discovery of a rich series of quartz veins and iron-capped lodes soon attracted the attention of miners and prospectors from Victoria, where mining was on the decline. Thus Southern Cross became the outpost station and food depot for prospectors. Parties started north, south, and east, and several finds were made. In the meantime prospectors at Kimberley having worked out the surface deposits, travelled south, and discovered the Pilbara field in 1890, Murchison in 1891, and Peak Hill in 1892.

In September, 1892, Bayley brought 500 oz. of gold to Southern Cross to Warden J. M. Finnerty, and claimed a Reward Lease for having found what he described as "payable gold" some 114 miles farther in a waterless country, which was called Coolgardie. The actual discovery of gold at Bayley's find was made some years earlier by two unknown men, whose skeletons were found, and on a tree near by was fixed an application notice for a claim, pricked out by a nail on a piece of tin. It is presumed that these men were killed by blacks before they could return and report their find. However, within a few days of Bayley's arrival at Southern Cross with his gold, the rush started, and in a very little time Coolgardie became world-renowned. Men flocked in from all parts, miners, and sons of the old pioneering families in the Eastern States, representatives of English companies, each tumbling over the other to secure some of the riches. Money flowed like water, and leases were purchased at prices utterly out of proportion to the potential value of gold in sight. Experts, whose experience in mining was frequently in inverse ratio to the fertility of their imagination, sprang up, and their advice was accepted with far greater appreciation than that of the trained men of sound knowledge and mature judgment. Those mining men who were at Coolgardie at that time will remember the type of expert, whose report frequently was written without his having seen the property. The number and grade of the lodes depended upon the size of the honorarium granted him by the vendors.

Out of this medley of fortune hunters, there evolved a fine type of pioneer prospector, who pushed out east and north, and the discovery of new "finds" followed in rapid succession. In June, 1893, Hannan found surface alluvial and quartz veins containing coarse gold on what is now Kalgoorlie. This was followed in 1894 by the finding of gold in lode formation on what has since become the richest area in the world ("the Golden Mile") by the Brookman exploration party. Within the next three years many new mining districts were discovered and opened up, notably Broad Arrow, Kanowna, Menzies, Leonora, Mt. Morgans, and Laverton, connecting up with the East Murchison. In 1896, the discovery of the deep alluvial leads at Kanowna brought the prospectors back from the outside fields. Claims could be taken up instead of leases, which meant that thousands of men were able to carry out intense development work on a small area. The sinking was shallow, from under the surface cement to 100 ft., the gold was easily and cheaply extracted from the wash, and the great lure to the prospector, "fortune," was in sight.

The prospector had become the alluvial miner, with the idea of alluvial gold being his by divine right. The question of the right to alluvial gold came into prominence at the first rush to Coolgardie. Although the leaseholders under the Goldfields Act, 1886, were entitled to all the gold within their four pegs, men swarmed all over the leases in search of alluvial gold. This was more or less assented to by the leaseholder, but when the alluvial men started to break off specimens from the reef at Bayley's mine, the owners naturally objected, and Warden Finnerty ruled that the alluvial men were not to work within 50 ft. on either side of the line of lode. Subsequently this provision was incorporated in the Goldfields Act, 1895. When the deep alluvial lead on the Ivanhoe Venture lease at Kalgoorlie was discovered, the owners held that the section referred to in the 1895 Act under which the lease was granted, was only intended to apply to surface alluvial gold. However, after considerable litigation, the Court held in favour of the alluvial miner, thereby creating a double title, lode gold to the leaseholder, and alluvial gold to the holder of a miner's right.

In April, 1899, deep alluvial gold was found on the Adeline lease belonging to the Hannan's Proprietary Development Company Ltd., on a block of ground let to a tributer. The writer had just then been appointed general manager of the company, and found that the whole of the lease had been pegged out as claims by the alluvial men. On looking into the matter, the company's legal advisers found that the lease was granted under the 1886 Act, previously referred to, and it was decided to fight the alluvial men. In spite of repeated warnings, the latter insisted on prospecting their claims, and injunctions were granted by the Warden to restrain them from doing so. These were disobeyed and some of the men were sent to goal, but the alluvial men and the public considered it a similar case to the Ivanhoe Venture, and feeling ran high. We were advised to give way to save bloodshed. However, being sure as to the legality of the company's rights, we intended to see it through, and as the miners were arming themselves a strong force of police was collected for the trial of strength. Sunday, October 19, 1899, was appointed the day of battle, and several thousand people assembled to see the men cart the alluvial wash from the lease, this being the "overt act" necessary for the prosecution for larceny. A few loads of this were carted away, and the names of the carters were taken by the police, but no arrests were made. Many of the miners were armed, and so were the police, but fortunately no shots were fired, and just at a critical time a priest came out from Kalgoorlie and took the leaders into town, and the trouble was over for the day. A truce was agreed to, no further work to be done until the Chief Justice gave his decision as to the company's title. This was, after considerable delay, given in favour of the latter, and the alluvial men loyally abided by it. The company on its side paid the alluvial men so much per ton, as the cost of mining and raising it, for all alluvial wash on the surface.

The present Mining Act, 1904, was so drafted as to give the alluvial men the right to object to the granting of a lease, if they can prove that alluvial gold exists, but when once it is granted, the leaseholder has all the gold within his pegs.

This matter has been referred to rather fully, as it marked an epoch, in that it practically suspended prospecting operations in new country. From this time comparatively few prospecting parties were sent out. Some centres, which had been discovered earlier, such as Meekatharra and Kookynie, were opened up. Youanme was found in 1907, but no find of any importance was made until April, 1910, when Charles Jones, who was backed by D. L. Doolette and some of his friends, found gold at a spot between Golden Valley and Southern Cross in a lode, the ironstone capping of which gave some wonderfully high assay results. An old-time rush started, experts who had not been heard of for years again blossomed forth, leases were pegged for miles, the Government built a railway from Southern Cross in record time, and for a few weeks every one talked of the "Bullfinch." Representatives of English companies were asked to send properties to London, but they wanted something more tangible than four pegs and a notice of application, and as vendors were only able to show where the Bullfinch lode should traverse their leases, very little business was done. Within a few months, nearly the whole of the area outside of Mr. Doolette's leases had been abandoned.

The one pleasing feature of this boom was the discovery of the most recent goldfield in Western Australia. A prospector named Weston, being unable to find any lodes outside the ground pegged, travelling to the west, discovered what is known as Weston's Reward Lease. This property has not turned out to be a payable one, but the discovery brought other prospectors along, and they found the Edna May group, comprising the Central, Deeps, and Consolidated Mines, which have been and still are producing a considerable amount of gold, and the centre has been called Westonia.

It is pleasing to note that in addition to finding the first goldfield in Western Australia, as before mentioned, Mr. E. F. Hardman suggested to a Mr. Stinton that certain country at Greenbushes should be tin-bearing. Shortly afterwards this prospector proved the truth of this suggestion of the Government Geologist. The discoveries of other base metal mines have been made by prospectors looking for gold, and no records are available. This brief history of discoveries would be incomplete without the name of West Australia's greatest son, the late John Forrest, whose pioneering exploration work blazed the track for the men who

> Followed fortune where she led,
> With fortune always on ahead,
> And always further out.

THE MINERALS OF ANATOLIA

By NORMAN M. PENZER, B.A., F.G.S.

The author gives particulars of the mineral deposits of parts of Asiatic Turkey, about which little is known in this country, though the Germans compiled records some years ago.

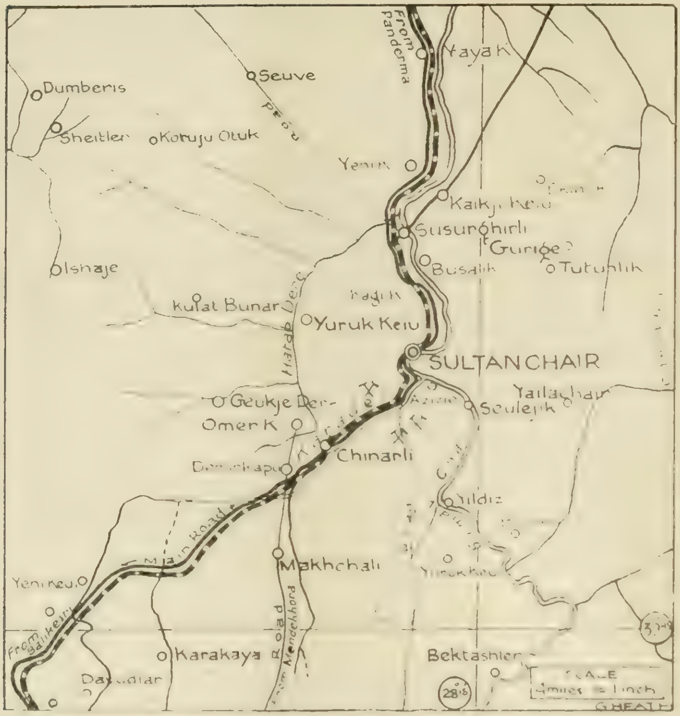
(Continued from October issue, page 221.)

NICKEL.—Nickel occurs in Aidin and Castamuni, but has hardly been worked at all. The Castamuni deposit is at Ak-kaya, about 31 miles north-east of the capital, and during the war has been requisitioned by the Ministry of War which has taken over the total output. The minerals extracted were sent to the chief steel works in Germany and Austria-Hungary. A representative of an English company visited the mines just previous to the war and reported that the nickel was too low grade to work. The Germans, however, apparently think differently, but perhaps it was a case of getting whatever they could in 1917 and 1918. No figures as regards the output are to hand, but it is probable that although at present the production is only small, there is a future for this mineral if more surveying and better communication could be made.

ARSENIC.—Arsenic is found chiefly in the vilayet of Aidin, at Aidin itself, Torbali, Tire, Darmara, and Odemish. It usually occurs in pockets in association with antimony, gold, or silver. The China mine yielded concentrates containing 35 to 42% of arsenic and 40 to 50 oz. of gold per ton. They have all been little worked. Deposits also occur near Angora and Castamuni, but little seems to be known about them.

TIN.—The occurrences of tin in Asia Minor are few and unimportant. At Mughla, sandjak of Mughla, vilayet of Aidin, there are stanniferous lodes. Near Darmara, 34 miles south-east of Smyrna, columbite occurs in quartz veins which are also stanniferous.

SULPHUR.—Deposits of sulphur are found in the vilayet of Aidin near the railway between Smyrna and Cassaba. They are very little exploited at present, but only need capital and initiative to start them. In the vilayet of Konia, sulphur occurs at Kechi Burlu (Boru) in the sandjak of Burdur. The sulphur is found near the surface and the percentage varies from 40 to 60. The annual production was 5,000 tons, but the Government have now directed that the output be raised to 10,500 tons. The number of miners is also to be increased. In 1918 the *Drogisten Zeitung* stated that a factory for the purification of sulphur was under construction. By this means and by the



MAP OF BORATE DISTRICT, ANATOLIA

larger output, the Government hopes in time to meet all demands of the Turkish vine growers who buy the sulphur in such large quantities. The Austrian Consular report for 1916 stated that the mines were exploited under the supervision of an Austrian expert. There are numerous springs in Sivas yielding sulphur and iron.

BORATES.—Borates occur in the vilayet of Brusa at Sultan-Chair, near Panderma, from which place is derived the local name of pandermite which is applied to the borate. Pandermite, although harder, is closely related to colemanite, which is a hydrated borate of calcium. Its chief value lies in the fact that it contains a higher percentage (about 56) of boracic acid than any of the other borates, with the two exceptions of boracite and stassfurtite, which are borates of magnesia.

The presence of these deposits has been known from time immemorial, although the natives had no idea what the substance was which they picked up on their caravan journeys across the Sultan-Chair basin to the Dardanelles. The potters established on the coast used the borate for glazing large earthenware pots, which they decorated in striking colours and exported chiefly to Constantinople. They were ignorant of its composition, and only knew it was fusible and useful in their trade. It was many years afterwards that borate was re-discovered.

This re-discovery appears to have been due to a French architect, M. Demazures, who in 1856 was constructing the Seraglio Point lighthouse. When engaged in this work he met a certain M. Grappler, the owner of a large marble quarry at Panderma, who invited M. Demazures to inspect it. The latter noticed that, in order to support the marble while being sawn, M. Grappler used native gypsum. This gypsum attracted the notice of M. Demazures, and on close examination he noticed that it was mixed with pieces of another mineral, the nature of which he could not determine on the spot. However, he sent a specimen to Paris and was informed that it was borate of lime, containing 40% to 44% of boric acid. The two Frenchmen, on receiving this information, sent an agent to inspect the deposits from which the gypsum had been extracted, with the result that they solicited a concession to work the same. The concession was at first refused, owing to the fact that the occurrence of borates was unknown in Turkey, but ultimately it was granted for a period of 20 years. The beds were then worked secretly, and small shipments were made to Europe, labelled "plaster of paris." Thus little became known of the deposits, and the dues and duties were for a time avoided. When, however, the Government found out what was going on, they placed the workings under the section of the "Regulations of Mines relating to Quarries." Later they were transferred to the laws regulating mines proper.

About 1880 a number of bore-holes were sunk to ascertain the points of greatest developments, though little was done till 1899. In the latter year the mines were acquired by Borax Consolidated, Ltd.

When the modern exploitation began, and inquiries were made to explain the numerous ancient galleries that had been discovered, it was said that they were the workings of the Genoese. But the Dardanelles potters had used the borate of lime many years before the advent of the Genoese to the coasts of the Aegean Sea. Although these old galleries were found, it was clear on close inspection that the first workings were open-cut, and that the galleries were made after the more accessible ground had been worked out.

Sultan-Chair may be taken as the centre of the deposits. It lies on the Manissa-Soma-Panderma branch of the Smyrna-Cassaba railway. It is 37 miles south-south-east of Panderma and 51 miles south-west of Brusa. The neighbouring villages near which the mines occur are, to the north: Susughirli or Susurlu, Busalik, and Kadi Keui, and, to the south: Azizie, Seulejik, Omer Keui, Chinarli, Baba Keui, and Yildiz. Nearly all these villages lie on the banks of the Susughirli Chai, which, after being joined in its meandering course by a number of tributaries, empties itself into the Sea of Marmora at Saslik Burun, 30 miles east of Panderma.

The basin of Sultan-Chair lies between gabbro, schist, and granite hills of early age. In this basin the sedimentary deposits have accumulated to a great depth, the chief being gypsum. An important volcanic upheaval took place during the formation of the gypsum, which in all probability caused the trachyte outflow found to the north of the basin. At the same time it gave birth to fumaroles of boric acid of an intensity varying with that of the movements; consequently changes occurred in the inclination of the dip, the immediate result of which was the formation of smaller basins, and subsequent layers of borate of lime. This explains the concentration of minerals in certain parts of the gypsum and its complete absence in parts distant from volcanic centres. The activity of the movements has not always been constant, and completely ceased during a certain period, to start again with more or less intensity.

The pandermite is divided into four classes, the mineral of first-class quality averaging 46 to 48% of BO_3. Each class is put apart and undergoes a sifting and hand-sorting before leaving Sultan-Chair.

As regards the export duty, it was originally very small, but that was when the export was known as sulphate of lime, or gypsum.

At Panderma the pre-war duty was about 16% on the value of the mineral. This value was arrived at quite arbitrarily. In 1885 the production was 1,500 tons, by 1892 it was 15,000, in 1903 it had sunk to 8,000, and in 1912 the production was about 12,000 tons of mineral, corresponding to 14,000 tons of borax and boracic acid. Just previous to the war the output had risen to 16,000 tons, but soon sank to under 11,000 tons.

The borate deposits other than those at Sultan-Chair are unimportant. There is one in Bigha, near Lapsaki, and another in the neighbourhood of Alashehr in the vilayet of Smyrna, but they are very little worked, if at all.

SALT.—Salt is fairly widely distributed in Asia Minor, both in the form of rock-salt and in solution in the numerous lakes. Previous to 1881 there were no Government regulations with regard to the industry, but in that year an Imperial Irade was issued, and the salt industry became a Government monopoly, worked by the Imperial Ottoman Debt Committee. There are a large number of deposits of rock-salt, but few have been worked owing to the easier way of obtaining salt from the streams and lakes. There are typical rock-salt mines at Changri, 56 miles south of Castamuni, in the vilayet of the same name. The entrance is small, but the cave opens out to an astonishing extent and displays a beautiful subterranean landscape, springs, lakes, natural bridges, &c. It is stated that these mines have been worked from the tenth century. In 1893 about 2,000,000 kilograms were extracted. Other mines, for the most part unexplored, occur in the vilayets of Bigha, Brusa, Angora, Aidin, Konia, and Sivas.

Apart from rock-salt deposits, salt is obtained from mouths of rivers, natural and artificial lakes, springs, marshes, ravines, &c. As can be imagined, the means of procuring the salt are most primitive. The inhabitants of the villages wait until the sea has formed layers of salt on the edges of the lakes and sides of the ravines, and workers of both sexes and of all ages collect it chiefly by hand, though a wooden shovel is sometimes employed. In some places exaporation is so complete that in summer salt lakes dry up completely, leaving a thick layer of salt. As is clear from the following table, there are springs or lakes in most of the vilayets, and it may be taken for granted that there are far more of both than are mentioned here, although they are not marked on the maps. In Angora the number of salt and hot springs is very large and they are used both for bathing and drinking.

Konia has by far the greatest number of salt lakes in western Anatolia, and contains the Tuz Cheullu (Gul) which is twice as large as any other lake included in our survey. The lake is very shallow and is said to be even more salt than the Dead Sea. It is almost impossible to swim in it and equally impossible to sink, so great is the salinity. Its shallowness makes it of course most valuable as a salt producer by evaporation.

The salt is derived from the lakes by evaporation, but no trouble is taken to increase the production which could be made enormous as the land is impregnated with salt for a very large area. As it is, Aidin is the largest salt producer. Among the deposits of this vilayet are the Charnalti salt beds, situated 16 miles W.N.W. of Smyrna on the coast opposite the Island of Keusten, in the Gulf of Smyrna. There are also beds, though less extensive, on the right bank of the Bakir Chai near Chandarli in the gulf of the same name, 38 miles N.N.W. of Smyrna. The other deposits occur for the most part in the south-western corner of the vilayet, although there are important ones near Smyrna.

In the vilayet of Sivas, salt is found at over a dozen localities. It is collected in reservoirs from which it passes to pans, where evaporation is natural.

The vilayet of Adana gets its salt from the south-east at the lakes Aktche Deniz, Hassan-Dede, and Bebely, and also at the mouths of its two chief rivers. The inhabitants of several villages have cut trenches from the sea to the lakes and the salt forms on the sides of the channels and on the shores of the lakes.

Saltpetre is got from the earth by lye-washing and is worked largely on the arid plains around Konia.

The following is a list of the chief salt deposits with their output wherever obtainable:

Vilayet	Locality		Production in Kilograms
ADANA	At the mouths of the Sevounn (Sihan) and Djethann (Jihan) and at the lakes above mentioned.		2,500,000
ANGORA	Hadji Bektash—117 miles S.E. of Angora		1,850,000
	Tepessi Delik—11 miles from Kir Shehr, 31 miles N.W. of Hadji Bektash		1,000,000
	Sekilo—32 miles from Yuzgat, 105 miles east of Angora		1,000,000
	Jogoul	Artificial Lakes	500,000
	Atche Kongoulou	Artificial Lakes	600,000
	Sari Kaza	Artificial Lakes	500,000
	Sunzu lu	Artificial Lakes	750,000
	Souldan Saz	Little exploited	—
	Chiback Saz	Little exploited	—
BIGHA	Bairamich		1,500,000
	Yekli—unexploited		—
BRUSA	Aivalik		2,500,000
CASTAMUNI	Changri		2,000,000
	Ikeleb	Salt Springs	4,600,000
	Bourga	Salt Springs	1,000,000
	Yeriou	Salt Springs	230,000
	Taita	Salt Springs	160,003
KONIA	Tuz Cheullu, &c	about	20,000,000
AIDIN (Smyrna)	Phocea (6 salt deposits)		—
	Menteche (very large deposits)		76,200,000
	Charnalti, &c		—
		Total	116,890,000
			= 116,890 metric tons

LITHOGRAPHIC STONE AND MARBLE.—Large beds of lithographic stone occur between Brusa and Panderma on the west, south-west, and south of Abulliond (Apollonia) Geul. The chief localities are near Michalij (5 miles from the lake), Kirmasti ($8\frac{1}{2}$ miles S.S.W.), and at numerous villages to the south of the lake.

The Michalij deposits are situated on the summit of the Dede-tepe, north-north-east of the town. They were discovered in 1892, and after going through a number of hands were transferred to Messrs. Pirie & Tyhurst, representatives of the Michalij Lithographic Stone Company, Ltd. This company had a capital of £225,000, and controlled an approximate area of 740 acres, for which £40,000 is said to have been paid. The stone itself is very pure and dense, and of a grey colour, but it is permeated with crystalline veins, and only 10% of the total stone was quarried. Workshops have been built containing cutting machinery, etc.

In the same neighbourhood, but sixteen miles to the east at the north-east corner of Abulliond Guel, lithographic stone occurs at Chatal Agkil; a concession for working was granted to an Englishman in 1901. The stone in this deposit has a yellowish buff colour. The beds at Dish Kaya in the caza of Gemlik, 12 miles south-east of the town, may also be mentioned. Little work has apparently been done, if any, on these beds, probably owing to the difficulties put in the way of concessionaires, but there are considerable hopes for the future. No figures are obtainable.

The chief marble quarries in Asia Minor are mainly in the islands of the Grecian Archipelago and on the Island of Marmora, which are not included in our survey. The famous quarries of Synnada in the sandjak of Afium Kara-hissar, vilayet of Brusa, are, however, still of importance. The ancient quarries are near Eski-kara-hissar. The marble is known as Synnada Docimian or Phrygian. The old city of Synnada is now only a village, while Docimium was the nearest town to the quarries. They were worked by the Byzantine Emperors, but attained their greatest development in Roman times, the Romans bringing great quantities of the marble to Italy.

One is struck by the great number and size of the ancient workings, specially the quarry of Buyuk Arylik. The quarry looks like a gorge or ravine entering the hill-side, and the marks of the hammer and chisel are still plainly visible. The quarries cover about $1\frac{1}{2}$ by $\frac{3}{4}$ of a mile, these being the limits of an isolated mass of marble, surrounded by basalt and trachytic rocks, which form the prevailing geological characteristics of the entire region. The marble is a highly crystalline limestone of great purity. The chief colour is white, but is often veined with sienna, orange, grey-blue, etc. Statuary marble is also found. Other kinds are red and purple veined pavonazetto, bright orange-veined marble, and a rose or flesh-coloured variety. A permit was granted about 1900, but the marble was not worked.

Other quarries in Brusa occur near the coast of the sea of Marmora and yield carrara, yellow, black, pink, blue, and rose-coloured marbles. A certain amount of alabaster and lapis-lazuli is also obtained.

In the sandjak of Ismid there are several quarries, some of which are abandoned. Those of Ah-hissar, 21 miles south-east of Ismid, are probably the most important at present. There are also numerous deposits of marble and alabaster in Sivas, but they are entirely unexploited owing to lack of communications.

In pre-war days a metre of marble cost 25 piastres (4s. 2d.), while in 1918 the price was 250 piastres (£2. 1s. 8d.).

KAOLIN AND FULLERS EARTH.—Kaolin deposits occur in the vilayet of Aidin at Menemen and also in the neighbourhood of Sivas and Tokat, but no information concerning them is obtainable.

Fullers earth is found around Eski-Shehr in nearly the same localities as the meerschaum. In fact in some cases deposits occur in the same mines as the meerschaum which they overlap. The deposits are about 3 ft. in thickness. The only other occurrence worthy of mention in Brusa is one near Michalij, close to the marble quarries already mentioned. In the vilayet of Angora deposits occur at Moalitch, 75 miles west of the capital.

CEMENT AND HYDRAULIC LIME.—On the gulf of Ismid there are large modern cement works at Eskihissar and close to Arslan (Aghiasma). The former of these manufactured the cement used for the Taurus and other tunnels, and also in the building of the Baghdad railway. The latter exclusively supplied the Ministry of War for buildings, &c. The produce of these two factories was insufficient to supply the demands of the State, and the price rose from 12 piastres per 50 kilogram sack to over 300. Hydraulic lime is made at these factories, but only in small amounts. It is also manufactured at Stenia on the Bosphorus.

BITUMEN, &C.—Under this heading is included asphalt and petroleum. Few discoveries have been made as yet, but close to Alashehr at the villages of Osmanie and Kozluja outcrops occur. Asphalt is found in Sivas, but details are lacking. Petroleum has been traced in Bigha, a few miles from the Dardanelles near Bergaz, but as yet is of little importance. During the war a petroleum source was discovered near Sinob in the vilayet of Castamuni, and a concession was granted to a Turkish subject for working the find for 99 years. Traces are also said to occur in Sivas.

OPALS.—Opals are at present of rare occurrence in Asia Minor, although there is reason to suppose that further exploitation of mines in some of the ancient volcanic regions would give rise to new discoveries. Opals were found in the island of Mitylene in association with chromium, but no details are given. The Natural History Museum at South Kensington has a fine specimen of fire opal from Sandschak, near Ushak, in the vilayet of Brusa.

The fullest description is given from a number of specimens found near the village of Karamanjik, which lies on the slopes of the Koja Dagh, seven miles E.S.E. of Simav, and 3½ miles N.W. of Shabhane, in the vilayet of Brusa. The spot is said to have been discovered in 1860 by an Englishman, but it was very little worked. The opals are found embedded in trachytic rocks whose presence is accounted for by the assertion that the neighbouring mountains were volcanic. One specimen of rock was so permeated with holes filled with opal that the entire stone was nearly opalized. Associated minerals include chalcedony, biotite, and felspar. A large range of opals occurs; precious, fine, milk, glass, wax, and common opals have all been found. In some cases the precious opals are interstratified with milky opals and chalcedony, and a single specimen displayed colours varying from the darkest red to a bright yellow. Some of the red opals display a scaly formation in which thick strata of fine opal alternates with very thin opaque. Specimens of hydrophane also occur, which display a wonderful variety of colours when immersed in water.

(To be continued.)

Volume III. of the Annual Reports of the Progress of Applied Chemistry has been published by the Society of Chemical Industry; price to members 5s. 6d., to non-members 10s. 6d. Volume I. is out of print. The price of Vol. II. has been raised, and is now 4s. 6d. to members, and 7s. 6d. to non-members.

The Geology and Mineral Resources of the British Possessions in Africa form the subject of a course of twelve "Swiney" lectures to be delivered by Dr. J. D. Falconer at the Imperial College of Science and Technology. The first lecture was delivered on Monday, November 10, and they continue on Mondays, Wednesdays, and Fridays of the following weeks. The hour is 5.30 p.m. and there is no charge for admission.

NEWS LETTERS.

CAMBORNE.

NON-FERROUS MINES COMMISSION. While the evidence submitted to this Government Commission is not yet available in detail, an outline of the proposals made by the various witnesses is known. The most interesting, and one likely to cause no little heartburning, is the proposal, made by Mr. C. A. Moreing, that the Camborne mines should be amalgamated and worked as one large proposition. The working mines included comprise East Pool & Agar, Dolcoath, South Crofty, and Tincroft. Originally, Grenville was also included, but obviously the situation of this mine in relation to the four groups mentioned and the fact that its workings are on an entirely different set of lodes, affected the feasibility of its inclusion, and we believe the idea has been dropped. If it has not, further consideration will, we venture to suggest, make such a course desirable. From figures culled from the Year Book of the Cornish Chamber of Mines, it would appear that in 1918 the four mines previously referred to produced 258,844 tons of ore, from which was extracted 3,067 tons of black tin, 1,575 tons of crude arsenic, and 161 tons of wolfram, having a total value of £771,799. The average recovery of black tin per ton of ore milled figures at 26·54 lb., but as East Pool & Agar, at the express wish of the Government, was extracting ore of more than the normal average, this recovery is obviously higher than can perhaps be looked for under ordinary conditions. The total monetary value of 59s. 7d. per ton of ore is also abnormally high owing to the exceptional prices of the metals produced. So far as black tin is concerned, the four mines produced in 1918 approximately 5 % of the total output from Cornwall. The number of men employed at the mines was 2,187, of which 987 were working underground and 1,200 at surface; this total would doubtless be higher in normal times, as in 1918 there was a considerable shortage at Dolcoath owing to the war.

In addition to the mines referred to, Mr. Moreing proposes to include the following, which are waterlogged at present, but which he regards of immediate importance: Tolgus (for the development of which capital has already been provided), North Crofty (owned by South Crofty, Limited), and the Roskears (owned by Dolcoath Mine, Limited). If an amalgamation of interests could be brought about, Mr. Moreing foreshadowed certain exploration work for testing the ore-bodies in these at present derelict mines by lateral development in the granite. The Tolgus lodes he would test by a 2,000 ft. drive from Agar shaft at the 255 fm. level and then by cross-cutting; this work would also prove the eastern ground in East Pool & Agar. North Crofty would be tested by a 2,400 ft. cross-cut from New Cook's Kitchen shaft in the South Crofty mine, but the shaft would first have to be deepened to get the right level. The Roskear setts would be tackled by a 3,600 ft. cross-cut from Harriett's shaft in Dolcoath. All these projected cross-cuts would intersect a large number of known lodes in the granite, lodes which in the killas were rich in copper, and the cost is estimated at approximately £116,000.

It is common knowledge that with current metal prices and existing high operating costs, no mines in the Camborne district are earning profits, so that to justify the expenditure of the large sum referred to in development, working costs must be materially reduced. In 1918 the average all-in cost at the four mines concerned was about 45s. per ton milled (it would have been nearer 40s. but for the Excess Profits Duty payable by East Pool & Agar, Limited), but wages and materials are probably higher this year, so that no reduction of the higher figure is likely, even although no Excess Profits Duty will be payable by East Pool & Agar this year. Mr. Moreing claims that to secure the desired reduction in costs, the scale of output must be substantially increased, and that this can be done most effectively by amalgamation. This would enable, too, the centralization of the milling and dressing plant, and obvious economies in pumping and other sectional costs to be brought about. For a central mill of a capacity of 25,000 tons per month, he opines that treatment costs can be reduced from 11s. 6d. to 6s. 10d. per ton, or in the case of a mill with double this capacity, to 5s. 6d. per ton. A plant with a monthly capacity of 25,000 tons would probably cost £295,000; and the saving would be equivalent to £69,600 per year. The larger mill is estimated to cost £488,000 and the saving is then figured at £180,000 per year. Altogether Mr. Moreing claims for centralization on the basis of 25,000 tons per month a total saving of about 10s. per ton, which would enable the mines to be operated without loss with tin metal at £240 and an average recovery of 25 lb. black tin per ton. With the larger programme, 20 lb. ore could be tackled without loss.

The scheme is clearly a bold constructive effort, worthy of the closest investigation by the Commission and by the interests concerned, for obviously vast economies can be effected by amalgamation and centralization. It would involve, however, the provision of a very large sum of money, which presumably would only be forthcoming if the Government assisted by guarantee or in some other form. The South Crofty interests are evidently not enamoured with the scheme, for already Captain Josiah Paull has expressed his belief to the Commissioners that the results claimed under the scheme cannot be attained, and we await with interest his detailed criticism. However, if the Commissioners view the proposal favourably, he has stated, on behalf of his principals, that they will not stand in the way.

Mr. Harold E. Fern also has submitted a scheme to the Commission for the resuscitation of mining in the famous St. Agnes district. His suggestion is to work the Wheal Kitty & Penhalls, West Kitty, and Polberro mines as one concern. All these mines have splendid past records, and owing to the frequent faulting of the lodes, all have large lode areas untested at quite shallow depths. He also gave evidence on the questions of mine licences and leases, royalties, the Tin Ticketing, and other general subjects.

Mr. Bennett, the manager of the Duchy of Cornwall Mines, has given evidence relating to mining in East Cornwall, and when representatives of the St. Just district have submitted their ideas, and Mr. Wethered, on behalf of the Cornish Chamber of Mines, has given the Commissioners a taste of his optimism and belief in the county's mineral resources, they should be in a position to prepare an interim report. The position of the industry is so critical that we hope there will be no delay in submitting their recommendations to the Government.

DISASTER AT LEVANT.—This famous old mine, the workings of which extend for over one mile under the sea at St. Just, was recently the scene of one of the worst disasters ever recorded in the long annals of Cornish mining, no less than 31 lives having been lost. It will be recalled that at this mine, the miners are lowered to or raised from the various levels by means of a man-engine. This particular man-engine appears to have been installed some 70 years ago, and has been in continuous use ever since. On October 20, at a time when the day-shift men were on their way to surface, the connecting link between the beam of the engine and the wooden rod, which works in the shaft, broke, and the rod collapsed, knocking away the platforms, and generally wrecking the shaft, particularly in that part above the 130 fm. level. At the time, it is stated, about 120 men were on their way to surface, and most were on the rod, as the engine was at the top of its stroke at the time of the accident. Some of the men were precipitated down the shaft; others were crushed or injured by the falling debris. To get out the killed and injured was a very hazardous task in view of the wrecked nature of the shaft, but the unassuming heroism of the Cornish miner was quickly in evidence, and there was no lack of volunteers when called for. Gangs of experienced shaft men were appealed for from other mines, and these men from Geevor, East Pool, and other mines, together with uninjured Levant men, worked unceasingly for days, until all the injured and dead were got out. We desire to associate ourselves with the many expressions of sympathy extended to the families of the men killed, and also to the management, particularly Major Freathy Oats (chairman of the company), and Captain Ben Nicholas, the manager.

The man-engine was introduced from Germany in 1842, in which year the first started to work at the Tresavean mine near Redruth. At the time it was hailed, as indeed it was, as a great improvement on the exhausting and slow method of descending and ascending the mines by means of ladders. The man-engine consists of a beam of wood, in 40 ft. sections bolted together, which extends from the surface to the bottom of the shaft (in this case 1,800 ft.) which is raised and lowered by a steam engine working at surface. Attached to the beam or rod, 12 ft. apart, are steps, each of which affords a foothold for one person, while on the side of the shaft are stationary platforms also 12 ft. apart. When the beam is at the bottom of its stroke, a man ascending steps on one of the small platforms attached to the rod. The beam rises 12 ft. and the man then transfers himself to one of the platforms fixed to the side of the shaft. At the bottom of the next stroke, he steps on to the rod again, is raised another 12 ft., and then again transfers to a shaft platform. He is thus raised to surface by lifts of 12 ft. The Levant man-engine was the only one left in Cornwall, and its supersession was only a matter of a year or two, for as indicated in these columns last month, a new vertical shaft had been decided on and the winding engine for it has already been purchased. Levant is also the last of the cost-book companies operating a mine of any size, and we fear the adventurers will have to face heavy calls for some time to come, unless the property can be sold to people with ample capital to sink the proposed new vertical shaft, and to install modern plant. At the time of writing, we understand that Mr. Henry F. Collins is inspecting and sampling the mine to this end.

WAGES OF SURFACE EMPLOYEES.—It has long been recognized that the surface men working at the mines have been underpaid, but remedial measures were out of the question, because the mines were being operated at a loss. This loss still continues, but not to so great an extent owing to the improved price of tin, and recently the Employers Federation has resolved that all men over 21 years of age, who have hitherto been receiving less than £2 per week, shall as from November 1, be given an increase of 2s. 6d. per week, or such a less sum as will bring their wages to that figure.

TINCROFT.—We hear good accounts of developments on the South lode in the Tyrie's section of this property, and the following figures, taken from the last monthly report, bear this out:

	Average width sampled	Assay-value lb. black tin per ton
224 fm. level	4 ft.	56
214 fm. level	4 ft.	60
208 fm. winze	4 ft	95

We hope, in spite of the present unsatisfactory financial position of the company, that ways and means will be found to continue to vigorously press forward the development work in the bottom of this mine.

KILLIFRETH.—From a report recently issued, it would appear that the unwatering operations, which commenced on March 15 last, have been delayed owing to a chokage in the shaft from the 10 to the 30 fm. level, which it has been a tedious and expensive task to remove. However, this has been successfully done, and the water is now well below the 40 fm. level on the North lode, and the 50 fm. level on the Middle lode. All the old stopes are being systematically sampled and assayed as the water recedes, and the results so far show that there is in sight about 2,000 tons of ore assaying 50 lb. black tin per ton. We have great faith in the possibilities of this property, but we still doubt, as we recorded in these columns at the time the work was started, whether the present company has sufficient capital to bring the mine to the profit-earning stage.

TEHIDY MINERALS.—This company is now the largest owner of mineral rights in the county, and it is therefore noteworthy that the directors have notified their decision that "the old system of granting leases on a royalty basis is contrary to the best interests of the mining industry." In substitution, as far as possible, they propose to encourage the formation of subsidiary companies to develop and work the various minerals on the estate, the intention being that instead of receiving royalties, the company shall have a substantial share interest in these undertakings. Presumably, this will mean, too, a share in the control, for otherwise there would be little to commend this course to other owners of minerals. We believe that the co-operation of the capitalist, the mineral owner, and the work-people in the control of the undertakings will prove a good buffer to nationalization, and, for this reason alone, should receive the support of the industry.

NORTH OF ENGLAND.

LEAD.—The position of the lead mines is certainly more cheerful than even a month ago; the price of pig lead has recovered to a level well above the controlled price in 1918, and the general anticipation of those who are familiar with the inner workings of the market is that we may expect a still higher figure. This has made an enormous difference to those mines whose principal output is galena, and the two or three large mines will be relieved of a considerable amount of apprehension. The past six months have, of course, caused the greatest anxiety to mine owners, and it is most unjust that during the reckless disposal of Government stocks of lead the mine owner should have been compelled to sell his output at ridiculously low prices. One just wonders what gross profit has been made by dealers in lead who acquired the State's stock at from £23 to £25 and are now retailing the same at £31. The Government might just as well have held the lead at a reasonable fixed price, and saved the tax-payer the margin that was absolutely thrown away. Even the most ill-informed official might have discovered that the world's price of lead was far above the recent level, and that to free the lead on the market would result in a collapse of price. Whoever is responsible for what was done deserves a handsome reward from the metal brokers.

There is now an insistent demand for lead products of all sorts, and several works are being started to make these direct from galena. The lead mines should keep their eyes open to this extra outlet, as every additional consumer helps to keep an open market for our ores.

ZINC.—As far as blende is concerned we are where we were. My statement last month as to the deliberate blocking of our outlet has been abundantly justified by the facts, and now the Government is negotiating with the object of saving the zinc smelters. This industry seems to have a pull somewhere, and will probably get its way and persuade the Board of Trade to grant assistance. I only hope that it will not be at the cost of the home industry. The Government is in a difficulty with its zinc concentrates, and it is not easy to forecast what will be done as to their disposal. I hope that the mine-owners will elicit some declaration of policy at the Committee, which will take evidence on this industry about November 11. There are many things to bring forward and my own view is that the Government should, as a minimum, give the output bonus from July, 1919, to June, 1920. Every mine has been compelled to sell at an artificially low price during the past six months and many mines have reduced their production considerably. I do not know of any where there has been an increase. It is to be hoped that there will be some report issued as to what evidence is given, as the reports on the tin industry give us no information that can help to form public opinion. As far as I have seen in the press the only cure suggested in Cornwall is that there should be an amalgamation of interests in Cornwall. Such a policy would hardly help the lead or zinc mines. These are generally isolated, and central management would not effect much saving, but I must admit that the mines could undoubtedly be more efficiently conducted than they are at present, and it is surprising to learn how meagre is the statistical records of many of the mines. The importance of this may be exaggerated, but I claim that no manager can properly conduct a mine unless he has well-kept records of all operations. Nevertheless, the Government should realize that no industry can possibly be well managed as long as its prospects are so hampered by uncertainty as to what the Government will do. The principal difficulty is, of course, the outlook for the sale of zinc concentrates, and I hope that next month it may be possible to know where we stand.

THE MINES.—In our district the outstanding feature is the stoppage of the Great Nenthead Mines, owned by the Veille Montagne Zinc Company. All the men have been discharged except a few who are working some of the best places. This very nearly disposes of the zinc concentrate output in the United Kingdom and the inquiry becomes daily more of a "post-mortem." The owners of the Threlkeld mine are going to accelerate the development of the newly discovered lode. They appear to have faith in the future of lead, and want to have a respectable output by the time it rises to £35. I believe that this mine will become the principal producer of galena in the Lake District within five years. Thornthwaite mine is still working on the reduced scale, but the manager tells me that he cannot see how the Government can possibly refuse the joint demands of the industry. I have seen no evidence to justify this hope, but the unexpected sometimes happens.

I hear of a most interesting situation at Mill Close mine, Derbyshire. The miners have made a threat that if all non-union men were not dismissed they would close down the mine. The owners refused to take this course and the men were instructed to strike. This step was taken, and the management promptly met it by sitting tight and keeping the pumps going at all costs. The staff cordially co-operated, and the loyalty of the non-union men was so pronounced that the owners offered work to any men who cared to take advantage of the opening. The result has been that enough men have started to work the mine, and there is now a considerable output of galena. Many owners are able to work happily with the men, but there is a breaking point if unreasonable demands are made. The Unions should realize that all the "co-operation" cannot be expected on one side alone, and there is not much evidence of a spirit of "give" on their side. Both parties should sink all minor points of dispute and make the mines a success at all costs. I have never yet come across a mine owner who was not willing and anxious to do the best he could for the men, and every effort should be made by the Union officials to foster this established tradition. Most of them are quite new to the industry, which cannot be compared with larger operations where the men are personally unknown to the owners.

Mr. Stretton has resigned from the acting management of the Force Crag mine, but is retaining the position of consulting engineer for the present. He is succeeded by Mr. Plant, who will take up the duties within a week or two.

THE COMMISSION.—The Lead and Zinc Mine Owners' Association is taking very active steps to present the case for the industry before the Non-Ferrous Mining Commission. It was arranged at a recent meeting that Mr. Onslow should deal with the negotiations that have taken place between the owners and the Government during and since the war, and that Mr. Anthony Wilson should present the claim for the extension of the output bonus to all mines until, as regards (a), galena, the Government stocks are disposed of, and, as regards (b), zinc, concentrates until the stock in Australia has been disposed of or alternatively until the production from the tailing heaps is disposed of. Mr. Anthony Wilson is also to concern himself with the question of the rating, royalties, and income-tax assessments. A member has been appointed to represent each district, and he will give an outline of mining past and present in his neighbourhood and an inkling of the potential possibilities if a reasonable price for sulphide is assured. Individual mine-owners will give evidence respecting particular features of their own companies. Mr. Onslow, it was arranged, should speak first and Mr. Anthony Wilson next. The Commission was expected to reach zinc and lead on November 11.

LABOUR QUESTION.—The District Council of the Industrial Committee for the North-West District arranged for a meeting to be held at Keswick on November 8 to discuss a number of local questions with regard to the relations between the owners and the men. The representatives were as follows: Scotland: Mr. Felix Wilson, managing director of the Leadhills, and Mr. John Mitchell, Wanlockhead. North of England: (East) Mr. Willis, Weardale; (West) Mr. Anthony Wilson, Thornthwaite; Mr. Cox, Veille Montagne. North Wales: Mr. J. L. Francis, Halkyn; Mr. N. Humphreys, East Halkyn; Mr. Philip Jones. Central Wales: Mr. Nancarrow, Lisburne Mines; Mr. Miller, Van Mines. Shropshire: Mr. W. Ramsden, Shropshire Mines. Derbyshire: Mr. Sam Potts, of Wass & Sons, Mill Close. Conway: Mr. Horace Boot.

MELBOURNE.

August 22.

BLYTHE RIVER IRON ORE.—The report of A. A. Boyd, C. G. Gibson, and G. W. Young, who were appointed a few months ago to examine the property of the Blythe River Iron Mines, Ltd., was presented to the House of Representatives on August 20, accompanied by a letter from Sir John Higgins, at whose suggestion the Federal Government had taken an option over the property at a cost of £3,000. It will be remembered that more than one adverse report had previously been made upon these deposits, and the report now presented fully confirms its predecessors. Sir John Higgins's covering letter compares the vastly different estimates of the quantity and quality of the ore available. In 1900 J. H. Darby, the English iron and steel specialist, estimated the quantity of ore available at 24,500,000 tons of selected ore, with an average value of approximately 8% silica, and 90% oxide of iron, equivalent to 63% metallic iron. In 1901 W. H. Twelvetrees, of the Geological Survey for Tasmania, estimated the deposits to contain from 17,000,000 to 23,000,000 tons. During May, June, and July of this year the three experts mentioned made a thorough investigation of the deposit, and they computed that the deposit contained 9,000,000 tons, and, further, that the bulk of the deposit was far too silicious to be considered as an iron ore at the present day, and that the quantity of ore was too small to be considered of any economic importance. For many years, Sir John Higgins added, the Blythe River deposit had been considered to be one of the largest bodies of high-grade ore in Australia, and its accessibility gave it an additional value. Assuming that the conclusions of Messrs. Boyd, Gibson, and Young were correct, then the reduction in the quantity of iron ores available for Australia was a serious national loss to the Commonwealth. The reports of the experts differed so vitally as regards the quantity and value of the ore that there was only one course which he could recommend the Government to follow, namely, that the right of purchase over the Blythe River Mines held by the Commonwealth Government be not exercised.

THE SOUTH MINE FIRE.—One of the most serious disasters, other than strikes, that has ever been experienced in the Broken Hill district occurred on the morning of July 30, when a large part of the South Mine mill was destroyed by fire. The fire was discovered at 1.25 a.m., and within three hours approximately £100,000 worth of valuable property had been destroyed. That the damage was not greater is due solely to the work of the city and mine fire brigades. The surface is covered with buildings, treatment plants, offices, etc., and stacks of timber and coal, produce dumps, and so on, and the whole is intersected by narrow lanes and roadways. There are several shafts, leading down to over 1,300 ft. The main shaft (No. 1) is in a hollow to the east of the main business offices. Around this shaft are the concentrating mill, ore bins, power plant (a new plant was just about completed), winding-engine plant, and technical offices. The fire destroyed the greater portion of the mill, the ore bins, and the head-gear. Officially reported, the extent of the damage was: No. 1 poppet heads, destroyed; No. 1 fan, motor, and shed, destroyed; mill engine-house and engine, destroyed; brace No. 1 shaft, destroyed; crude ore bins, destroyed; Gates crusher section of mill, destroyed; Gates crusher ore bins, destroyed; rolls crusher ore bins, destroyed; rolls section of mill, partly destroyed; jig section, partly destroyed; grinding section, partly destroyed; belt store in mill, destroyed; cut timber around No. 1 shaft, destroyed; steam mains and trestles, severely damaged; new power house, slightly damaged. The fire was not got under control until 4 o'clock, and the ruins continued to smoulder for 48 hours, when the blaze was reported "practically out." While the fire was at its worst it was a magnificent though melancholy sight. The flames from the roaring mill timbers, bins, and poppet heads rose to a great height, and according to reports, could be seen as far away as Cockburn, 30 miles distant. Great risk was taken by the firemen in combating the flames, and several narrow escapes from serious injury occurred; but brave work saved the new power plant, the winding engine house, and the table section of the mill. It is almost inconceivable, looking into the ruins, in the very heart of this great cluster of buildings, that anything at all could have been saved. The view was reminiscent of the photos of the damage done by the Germans in Belgium and France. The cause of the fire so far remains a mystery. That the buildings were set on fire is more than a possibility. Whether organized Bolshevism was responsible, or whether the fire-bug was an individual maniac, has yet to be proved. On Saturday, the 19th, Sunday the 20th, and Saturday, 26th of July, outbreaks of fire occurred among the surface workings of the mine, but in all cases were checked. The first two were looked upon as mere accidents, the result of short electric circuits. The third was unexplainable, and the outbreak was only extinguished after considerable trouble. Opinions vary as to whether the disastrous fire was accidental or intentional, but nine out of every ten men—including the men on strike—hold to the arson theory. The plant was insured. The company will replace the plant, but for various reasons—partly because some of the machinery must be obtained from overseas—it will take from 18 months to 2 years before its re-erection can be completed. There were about 1,200 men employed on the mine before the present strikes. For the next 18 months or two years at least 1,000 of the men, even if the strike were declared off, must remain unemployed as far as this mine is concerned. Rumour has it that the directors may offer a reward of £2,000 for the identification of those guilty of the fire. If, in addition, the Government should offer £1,000 and the Associated Mines another £2,000, making £5,000 in all, the actual culprits may be secured. The prompting culprits, of course, all Australia knows, but this particular crime cannot be brought home to them. Broken Hill has had some serious mine fires before, but the South mine surface blaze takes its stand as the most serious in Broken Hill's history.

WEST AUSTRALIAN BASE METALS.—The Mining Association of West Australia is up in arms against the Federal law prohibiting the export of base-metal concentrates from Australia. Particulars of the hardships involved and the hopeless position of the mines and smelters have already appeared in the Magazine. The Association has addressed a memorandum to the State Government on the subject, and a deputation waited on Mr. W. M. Hughes at Perth on his return from England. The memorial says that the Government control of metal output is unjustified and harsh. It is impossible to smelt lead and tin concentrates in West Australia, and the charges of the smelters in the eastern Australian states are utterly impossible, being from 60 to 100% higher than English charges. Cases of excessive charges by smelters in the eastern states are given. For instance, early this year two tin producers at Greenbushes had arranged to export 50 tons of concentrates to England, an arrangement had been completed with a Liverpool firm for the sale of the consignment, and the Controller of Shipping had allowed the necessary space, when at the last moment the Acting Prime Minister intervened and prohibited the export. On the date that this tin ore would have been sold in England the price offered by Kelly and Co., tin smelters, of Sydney, was £21. 13s. per ton of metal less than would have been realized in England, after paying the high freight then ruling from Fremantle to Liverpool, namely, £6 per ton. Again, a shipment of silver-lead ore from a mine in the north-west was sent to the Associated Smelters, Port Pirie. It was high-grade ore, containing 67% metallic lead and 20 oz. silver per ton, the value being about £21 per ton. The charge made by the smelters, for smelting only, amounted to about 42% of the value of the metals, and after the costs for mining, bagging, transport, etc., were deducted, the producers found themselves out of pocket, so the mine was closed down. Another instance cited is the Whim Well copper mine. Since the mine was opened in 1906, 60,000 tons of 14% ore have been shipped for treatment. This ore was obtained by hand-picking from 8% ore, the residue, now amounting to about 90,000 tons, being dumped for subsequent treatment on the mine. In an application to the Prime Minister about two years ago, figures were given showing that with silicious copper ore of a grade of 11%, the difference in price realized on shipments made during 1916, in England and in Australia respectively, was £44 per ton of metal. Against this great disparity in value has only to be set the difference between the freights to England and to Port Kembla, which normally is trivial. Under ordinary conditions, treatment charges in England on 15 to 20% copper ore may be taken at £15 per ton of metal less than the charges at Port Kembla, and after allowing for all charges, including realization and freight, either to England or to Port Kembla, the advantage of sending such ores to England, as compared with Port Kembla, is from £15 to £20 per ton of copper contents.

The case of lead is stated on similar lines. In 1914 it was customary to ship lead to Europe in the form of 70% concentrate, where it was refined at a cost, including freight from Fremantle, of not more than £4 per ton. These charges enabled the industry to be carried on successfully, although the selling price for pig lead did not exceed £19 per ton. With lead at £29 per ton, and special shipping facilities provided by the Imperial Government for transport of the metal, the heavy charges involved in local treatment could be met, but now that the war is over, the special shipping facilities have ceased, the price of the metal has fallen, and it has become a commercial impossibility to mine lead profitably. Two consignments of lead concentrates treated at the Fremantle smelters in December, 1918, were subjected to the following charges: No. 1, 29·25 tons of 66% concentrates, treatment charges, £12. 13s. 6d. per ton; No. 2, 27·65 tons of 69% concentrates, treatment charges, £11. 3s. 9d. per ton.

As reported by the *Industrial Statesman & Mining Standard*, advantage was taken of the presence of the Acting-Prime Minister in Perth, whither he had gone to welcome the Prime Minister, Mr. W. M. Hughes, on his return from England, to place the position before him. Mr. A. E. Morgans, president of the West Australian Mining Association, was the principal speaker, and he said that while they agreed with the Federal Government's policy, the burden should not fall wholly on the producers of metals. A bonus should be given. He feared that the Broken Hill companies were making outside customers pay for the cheaper smelting of their own ore. Mr. Watt asked if the situation would be met by erecting a really up-to-date smelter by the West Australian Government alone or in co-operation with the Federal Government, and was assured that it would, and that if this were erected at Geraldton there would be a prospect of a profit of £2 or £3 per ton on lead concentrates, but if the ore had to be sent to Fremantle the profit would be less than £1 per ton. Mr. Watt promised to consult with the Government metallurgical adviser and with Mr. Hughes to see how far they could relieve the pressure on the State until arrangements could be made for treating the ores in the west.

TORONTO.

October 13.

SUDBURY NICKEL.—The production of nickel, which had been greatly stimulated by war requirements, was suddenly curtailed when the armistice was declared. It is now recovering with the development of new markets, as the use of nickel in connection with staple manufacturing industries is increasing. It is specially in requisition for alloy purposes in the manufacture of automobiles, where a hard metal is required. The International Nickel Co. is steadily increasing the scope of its operations, and its present output is nearly equal to that before the war. Mining at the Creighton mine has been actively resumed with an output of about 1,300 tons of matte per month, which is shipped to the refinery at Port Colborne for treatment. Four of the seven furnaces are in operation. All the ore is now sent to the new roast beds at O'Donnell, 26 miles west of Copper Cliff. A new nickel centre is growing up at Coniston, seven miles east of Sudbury, where the extensive plant of the Mond Nickel Co. is situated. The company is now employing about 700 men and has resumed the shipment of nickel matte to the refinery at Swansea, Wales. The present smelting capacity of the Mond Co. is four furnaces and three converters, but the company has in contemplation the construction of three additional furnaces and three converters at an estimated cost of $3,000,000. Work on this extension has been for some time delayed on account of unfavourable conditions. The British America Nickel Corporation, which has an official connection with the British Government and will supply nickel for armament purposes for the Navy, is building a large plant at Nickelton, three miles north-west from Sudbury, comprising three furnaces and three converters. A force of 800 men is now engaged in construction work. It is hoped to begin production early in the winter, employing about 1,800 men. The ore will be obtained from the Murray mine at the site of the smelter. The company's refinery is under construction at Deschenes, Quebec, on the Ottawa river, and the electrolytic process will be used. It is stated that the company has proved ore reserves to the amount of 8,000,000 tons.

PORCUPINE.—The gold-mining industry is handicapped considerably by labour shortage. The rate of pay is higher at the Cobalt silver mines and the high wages offered by the lumber companies are attracting many who would otherwise be employed in the gold mines. The Hollinger Consolidated has issued an interim report covering the period from January 1 to September 9, showing a total income of $4,839,845, with expenses of $2,433,958, leaving net profits of $2,405,887. Dividends amounting to $984,000 have been paid and $1,421,887 added to the surplus, which now stands at $3,493,174. The cost of treatment of ore was $4·82 per ton compared with $4·95 for last year, and the average value of ore treated was $9·99 per ton compared with $10·24 in 1918. The number of employees has fallen from 1,344 on June 17 to 1,187 on September 9. The annual report of the McIntyre for the year ended June 30 shows gross earnings of $1,671,646 and net profits, before providing for depletion of mining profits or war taxes, of $683,350. The ore reserves were estimated at 433,057 tons valued at $11 per ton, the average value having been materially increased by the ore developed on the 1,125 ft. level. The development programme laid down contemplates the continuous sinking of the main shaft which has now reached the 1,400 ft. level. The Dome is treating about 900 tons of ore per day, employing a force of some 800 men, which it is endeavouring to increase. At the Sovereign a promising vein highly mineralized with iron sulphides has been found in trenching.

COBALT.—The silver-mining industry has fully recovered from the effects of the strike, and the producing mines are again in steady operation, with plenty of labour available. One noticeable effect of the strike settlement has been a considerably higher degree of efficiency among the workers, the spirit of unrest and dissatisfaction having completely subsided. Production is increasing under the stimulus of the high price of silver, and the output of the last quarter of the year bids fair to exceed that of any previous three-monthly period. The La Rose Consolidated has made a discovery of high-grade ore at the 100 ft. level, and is also working a high-grade vein on the Princess property. A rich vein on the University property is being opened up. The Nipissing Extension, capitalized at $3,000,000, has purchased the Farah property, on which a discovery of rich ore was made in June last. Major E. H. Birkett, formerly of Idaho, has been appointed manager. The annual report of the Kerr Lake for the year ended August 31 shows a production of 1,482,649 oz. of silver and 90,586 lb. of cobalt.

LETTER TO THE EDITOR

Jumbil and Trevascus.

The Editor:

Sir—In your editorial comments in the September issue of the Magazine, upon the letter in which Messrs. Ashurst, Morris, Crisp & Co. refute every statement you publish on the subject of the Trevascus mine and Mr. Calvert's connection with the company which is working that property, you accept the correction that the assay-values of 30 lb. of tin per ton for the Great Trevascus lode were given by Major Bullen, and add: "No doubt Mr. Calvert accepts the figure. . . . ."

If this surmise is intended as a reflection upon the accuracy of my figures, or implies that Mr. Calvert or the company should not accept them, I shall be glad if you will state your reasons for the aspersion.

As the Great Trevascus lode has not been seen, let alone sampled, by any assayers but ourselves since the mine was closed down, and as we had to clear the levels and stopes in order to do the sampling, I am at a loss to understand how you can claim the right to question our figures, and I challenge anybody to refute my report. I may add that in so doing I am backed by Mr. H. R. Beringer, Instructor of Chemistry, Assaying, and Mineralogy of the Camborne School of Mines, under whose supervision our assay department was built, equipped, and staffed, and the assays in question were checked.

F. BULLEN, *Major.*

Camborne, October 7.

[We are not aware that our remark "No doubt Mr. Calvert accepts the figure" constitutes an aspersion. Major Bullen might just as well entertain the same supposition with regard to Mr. Calvert's denial that he was responsible for the figure. Major Bullen states that the Trevascus lode has not of late years been sampled by anyone but his own party. That is just our grievance.—EDITOR.]

PERSONAL

A. H. ACKERMANN has returned from Transylvania.

M. A. BRUCE left last month for Nigeria to take up the management of the Bongwelli properties.

CAPTAIN L. MAURICE COCKERELL has resumed practice at 3, London Wall Buildings, on the closing of the Mineral Resources Development Department.

W. F. COLLINS left for China on October 25.

D. DALE CONDIT has accepted a position as oil geologist with S. Pearson & Son, and will go to India and China.

CUTTEN BROTHERS have moved their office from Capel House, New Broad Street, to Bank Chambers, 329, High Holborn, W.C.1.

T. M. DAULTON has left Atlin, British Columbia, for the Philippine Islands to develop placer deposits.

J. C. FARRANT is going to the United States for about three months.

T. J. FOSTER has returned from West Africa.

R. D. GILL is the president of the Cornish Institute of Engineers for 1919–20.

W. H. GOODCHILD has gone to South Africa.

J. WENSBY GRAY is expected back from Mesopotamia on demobilization from the 85th Burma Rifles.

R. H. GREAVES has returned to Egypt.

THEODORE HADDON is here from Rhodesia.

JAMES M. HOLMAN and LEONARD HOLMAN are on their way home from India, on the conclusion of a tour through the mining districts of the world.

AUSTIN Y. HOY, London manager of the Sullivan Machinery Co., was married last month to Miss René Pavitt, of Wimbledon.

J. M. ILES is leaving shortly for Australia.

T. J. JONES is back from Siberia.

A. E. KITSON left by the Appam on October 22 on his return to West Africa.

E. A. LANG left for Colombia on November 6.

FRANK E. LATHE, lately with the Anaconda, and more recently at Chuquicamata, has been appointed chief chemist of the British America Nickel Corporation, at Sudbury, Ontario.

J. G. LAWN is leaving for South Africa to take up the position of managing director of the Johannesburg Consolidated Investment Company.

Dr. MALCOLM MACLAREN has returned from Bucharest.

D. P. McDONALD is here from Rhodesia.

SIR HENRY A. MIERS, Vice-Chancellor of the University of Manchester, has been appointed a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

H. G. NICHOLS has left for Mazapil.

A. J. A. ORCHARD has been re-elected president of the Manchester Geological and Mining Society.

WILLIAM PLANT has been appointed manager for the Braithwaite Mines, Ltd., Cumberland.

C. W. PURINGTON is back from Siberia.

A. MCINTOSH REID has been appointed Assistant Government Geologist for Tasmania.

GILBERT RIGG has returned from Australia to England by way of the United States.

H. G. SCOTT, manager for the Siamese Tin Dredging Company, is in London.

H. V. SEALE has been appointed manager of the Junction North mine, Broken Hill.

S. F. SHAW is superintendent of the Charcas Bonanza, Asientos, Zacatecas, and Zaragoza units of the American Smelting & Refining Co., in Mexico.

W. E. SIMPSON has returned from Scotland to Canada.

COLONEL RALPH STOKES, Chief Engineer Archangel Forces, has returned from North Russia, and will resume mining work early next year.

E. O. TEALE is on his way back to West Africa.

J. W. TEALE, of Bainbridge, Seymour & Co., Ltd., left for Brazil on November 4.

D. A THOMPSON is here from Abosso.

T. G. TREVOR is here from South Africa.

P. M. TYLER is in England on behalf of the United States Tariff Commission.

THOMAS WEIR has left for Nigeria.

A. STANLEY WILLIAMS has left for Nigeria

PERCY P. WOODHAMS, representing the Climax Rock-Drill & Engineering Works, is visiting South Africa.

LOUIS A. WRIGHT left New York on October 22 for Italy, where his address will be Via Parlimento 22, Rome.

W. F. COLLINS, manager of the Filani mine, died in Nigeria last month from blackwater fever.

FRANK SIMON, general manager of the Tweefontein United Collieries, died suddenly in September.

CHARLES MCCONNELL, one of the best known mine managers in Ontario, died in September. He was connected with the Hargraves mine in 1905, and later with the Trethewey and the Tough Oakes. His last managership was at the Patricia, Boston Creek.

TRADE PARAGRAPHS

THE RAPID MAGNETTING MACHINE CO., LTD., makers of electro-magnetic ore separators, have moved from 18, Crescent, to Magnet Works, 52, Lombard Street, Birmingham.

HYATT, LTD., of 24, Devonshire Street, London, W.C.1, announce that they have taken over all matters pertaining to the Hyatt Flexible Roller Bearing for England and Continental Colonies.

AGRICULTURAL & GENERAL ENGINEERS, LTD., of Central House, Kingsway, London, W.C.2, the formation of which was noted in our last issue, send a preliminary catalogue giving an outline of the range of their manufactures. Among these are winding engines for mines and aerial ropeways.

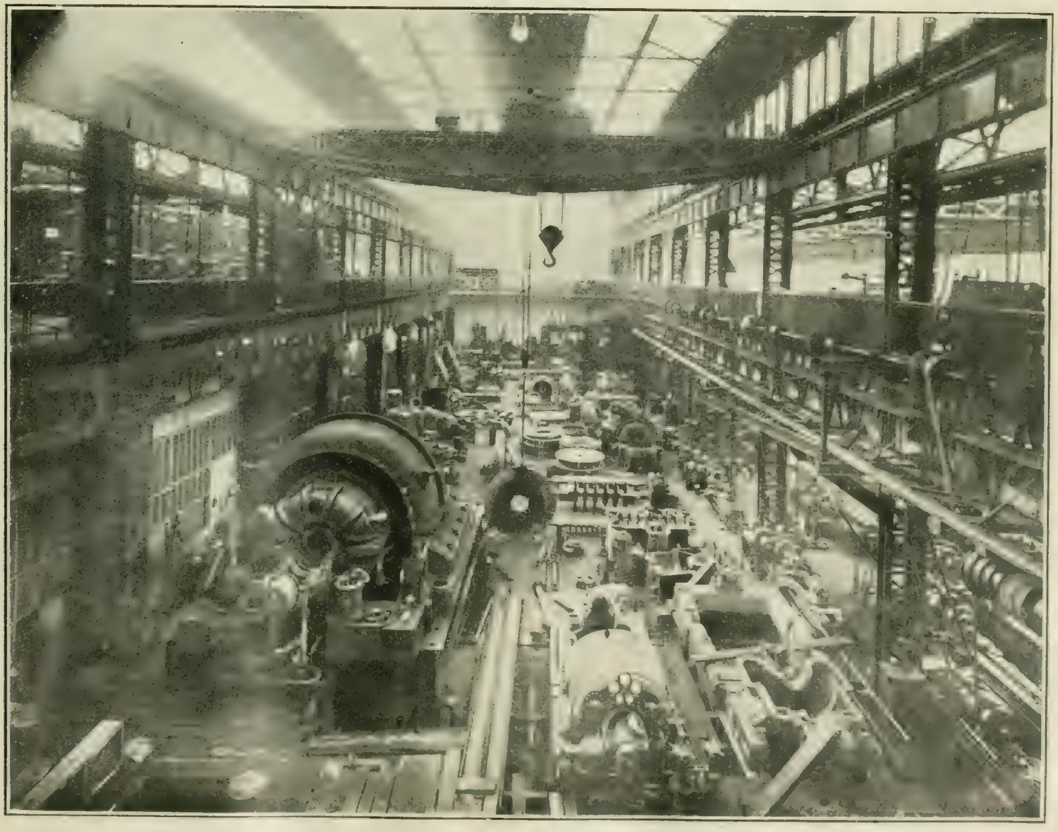
THE WORTHINGTON PUMP & MACHINERY CORPORATION, of 115, Broadway, New York, send us a number of bulletins as follows: Horizontal Double-Acting Single-Cylinder Power Pumps; Single and Duplex Boiler-Feed and Tank Pumps; Log Washers; Spirojector Condensers.

VISIT TO THE FRASER & CHALMERS ENGINEERING WORKS AT ERITH.

On Monday of last week, at the invitation of the management of these works, a number of representatives of the Press made a tour of inspection of the extensive plant at Erith, Kent. As is generally known, the G.E.C., in April, 1918, purchased the business of Fraser & Chalmers, Ltd., which from the year 1893 manufactured machinery for metalliferous mines and metallurgical works. But the F. & C. operations were not confined to this particular kind of machinery, for they were practically the pioneers in this country in the development of the Rateau impulse type of turbine, while they were also known for their conveying, loading, transporting, and handling plants. Further, they were instrumental in producing the dry gas cleaning plant for blast-furnace gases, which is still in operation in a number of the large steel works in this country. Since the combination of these two companies the works have been reorganized from war conditions, with a view to concentrating attention on turbines, turbo-blowers, rolling-mill equipment, and general engineering; and although they already cover an area of about 18 acres, are not sufficiently commodious for their rapidly-extending business, and call for considerable extensions to make adequate provision for the ever-increasing call upon the company's resources. Situated close to the river Thames, and within easy access of London, it will be seen that they are well placed for both the inland and export trade.

The foregoing conveys very little idea of the magnitude of the works which it was our privilege to inspect. Passing from the maze of general offices one stepped into the Drawing Department, where between 30 and 40 draughtsmen were busily employed, the *fons et origo* of some of the great mechanical productions seen later. From this point the more practical parts of the establishment were seen, especially when, on entering the General Engineering Shop, there was brought into view the overhead cranes carrying up to 25 tons, and the boring, turning, planing, and slotting machines. The Smiths' Shop, with its steam hammers, sawing and cutting off machinery, and oil-fired annealing furnace, gave one the impression that there was very little, if anything, that could not be done there. The Foundry, which in ordinary times would be a place of great activity, was strangely silent; not because there was no work to do; on the contrary, there was an abundance, but the fires were out, and the workmen were absent. This particular part of the works, which are centrally situated, is composed of two main bays measuring 360 by 155 ft., and the entire length is covered by six 25 ton electrical overhead travelling cranes, and castings up to approximately 35 tons weight are provided for.

A very different aspect was presented on entering the Boiler and Plate Shop. Here all was activity; huge plates were being rolled and drilled, the process of riveting was to be seen, and welding in various stages of operation was being carried on. With the remarkable development of the turbine, the section where these are built proved very attractive. This shop has been specially designed for the manufacture of large steam turbines, turbo-blowers, and turbo-compressors, and is equipped with boring and turning mills, planing machines, lathes, presses, &c. In this shop there were many test beds with condensing plants beneath, as every machine is tested before its despatch. On either side there is a gallery, one of which is devoted to the manufacture of blades for turbines. The other is given up to assembling, riveting, and finishing wheels for turbines and blowers. In this department also were to be seen many types of turbines, ranging from 500 kw. upwards. At present the F. & C. Works have under construction for the Glasgow Corporation a high-pressure machine with a normal capacity of 15,000 kw. and the overload up to 23,500 kw., run-



ERECTING BAY OF MACHINE SHOP, FRASER & CHALMERS ENGINEERING WORKS, AT ERITH.
Showing 15,000 kw F. & C. High-Pressure Turbine under construction.

ning at 1,500 r.p.m., and designed for divided flow in the low-pressure stage. This is near completion, as are others for China, South Africa, etc. There was also to be seen in an advanced state of completion the largest turbo-compressor built in this country, having a capacity of 20,000 cu. ft. of free air per minute against a pressure of 100 lb. per sq. in. developing 4,100 b.h.p.

In the department dealing with mining machinery it is to be noted that F. & C. produce stamp-mills, tube-mills, Hardinge conical mills, Dorr machinery, crushing and screening plant, concentration machinery, indeed all the auxiliaries for a complete mining equipment. Much attention has been given since 1912 to dry gas-cleaning plant, a system which was begun in Germany, but the F. & C. Works are now the sole manufacturers in Great Britain of the Halberg-Beth process. The first plant installed in this country was a small capacity unit of 350,000 cu. ft. of gas per hour, whereas, showing the rapid advance made, the largest plant now under construction will effectively deal with 9,000,000 cu. ft. per hour. Passing through the Wood-working Department, the Pattern Shop came in for inspection, and there one saw the designs that had been worked out in one department being prepared for yet another.

During the war this Works contributed in no mean measure to the success that attended our efforts, and brought us victory, contributing as they did pontoon boats, armoured cars, heavy gun parts, shell dies, and a host of other essentials too numerous to mention here.

Before the return journey was made, the guests were invited to partake of the company's hospitality, during which Mr. Hirst, Chairman of the G.E.C., delivered an illuminating speech on the company's operations and its future expansion. He was supported by Mr. E. W. Wilson, who, in a very brief speech, alluded to the good training he had received from the previous speaker, under whom he had served for 27 years. Mr. S. Rentell, of "Electricity," made suitable reply for the members of the Press, thanking Mr. Hirst, whom he had known for 33 years, for the opportunity afforded them of inspecting the works at Erith, and also for the hospitality shown to them.

THE SHIPPING, ENGINEERING, AND MACHINERY EXHIBITION.

The period originally fixed for this exhibition was extended by four days, owing to the inability of numbers of visitors from the Midlands and the North to reach Olympia during the railway strike. From the moment when something like a normal train service was obtained the success of the exhibition was assured. In addition to the brief sketch that appeared in the October issue, the following notes will be found of interest to mining engineers.

BABCOCK & WILCOX, LTD., of Farringdon Street, London, and Renfrew, showed models of some of their manufactures, and also of appliances for the saving of labour in handling materials. In 1889 they introduced their patent marine-type boiler, which has made continuous progress ever since. It has many advantages, being adaptable for either coal or oil; all the tubes are straight, all joints expanded, and every part is easily accessible for cleaning or repair. They also showed an automatic water-softening plant, among its principal features being the simplicity of its working and the fact that treatment can be carried out in hot or cold. The model of their gravity bucket conveyor showed a typical conveyor installation, comprising filler, driver, wheel curves, and chain and buckets. Any material delivered through the filler into the buckets is carried undisturbed to the point of discharge, the whole of the chain running on wheels automatically lubricated. In addition the firm specializes in the construction of patent tray conveyors, and had on exhibition a collection of conveyor parts, buckets, trays, links, chains, &c.

DAVIDSON & CO., LTD., of the Sirocco Engineering Works, Belfast, had a number of exhibits. One of these was a marine forced-draught set, with a 35 in. diam. "Sirocco" fan, direct-coupled to a "Sirocco" enclosed forced lubricated engine, supplying air to special furnace fronts through a pre-heater arranged in the boiler up-take. They also manufacture air washers, induced draught fans, steam heater units for factory heating, fans for ships' ventilators, high pressure fans for cupolas, forge fires, dust fans, and hand-driven fans. Their mine fans are, of course, well known.

JAMES KEITH & BLACKMAN CO., LTD., of 27, Farringdon Avenue, London, E.C., had a variety of blowers and fans for all kinds of ventilation, for saloons, staterooms, stokeholds, bilges, tanks, workshops, public buildings, &c. They had also a "K.B." smith's hearth, a down-draught smith's hearth, a "K.B." coppersmith's fire, with direct-coupled electric blast fan, and a "Keith" centrifugal fan, belt and electrically driven, for ventilation, fume, steam, and dust removal, mine ventilation, &c.

SIEMENS BROTHERS & CO., LTD., of London and Stafford, showed cables for electric lighting and power suitable for installation upon ships, loud-speaking telephones for use between the bridge, engine room, and various positions on deck; a helm indicator for showing on a dial the angle of the rudder or helm, an advantage in this device being that the instrument may be placed either on the navigating bridge or elsewhere; and a navigation light indicator, to show at a glance whether the navigation lights are all burning. The use of this indicator is apparent, the failure of a light being revealed immediately. In addition they had a searchlight projector, a "Siemens 24 in. Suez Canal" pattern with split mirror and an 80 ampère lamp, switch pillars, and panels; also a complete wireless telegraph station, being a standard ship's installation, with an emergency transmitter for use when the main source of electric supply is not available, a valuable feature being its compactness and the almost complete absence of noise. To mining engineers the firm is known for its work in connection with the electrical equipment of mines.

THE VARIABLE SPEED GEAR, LTD., of Broadway Court, Westminster, were exhibiting their Williams-Janney hydraulic variable speed gears. These are suitable for any purpose where it is desired to convert a constant speed in one direction into an infinitely variable speed in either direction, and to develop a high starting torque. These gears are applicable to capstans, windlasses, winches, cranes, and other appliances for hoisting and hauling.

THE WHIRL ROTARY PUMP CO., LTD., of Stratford, London, E., showed their pump. Every part of this pump is easily accessible, and can be withdrawn without in any way disturbing the pipe connections. The pump is particularly adapted for fluids and semi-fluids where large volumes have to be dealt with quickly and economically. Its other advantages are its positive action, its lightness in weight, and the small amount of floor-space it occupies.

THE BRITISH FLOTTMANN CO., of Cardiff, specialize in drills and machines for boring shot-holes in mines and quarries. The drills are constructed of solid forgings of highest grade steel, each part being subjected to a case-hardening process in order to give to the machine a long life and render it immune from breakage, despite the fact that the drills have a most severe test put upon them, approximately 2,500 blows a minute being delivered. Among the great variety of their exhibits they had, too, a drill for submarine work, which they claim is just as easy to work as an ordinary hammer-drill is in a mine or quarry. Compressed air is the principal force used, but in cases where this system cannot be adopted steam can be easily applied. They had also hollow drills, and twist drills, with cutting bits of various shapes.

W. & T. AVERY, LTD., of Birmingham, had a fine exhibit of weighing machines in great variety. Their automatic grain weigher is constructed on the principle of the equal armed beam, on one end of which is the weigh hopper of the machine, and on the other the weight box containing the dead weights to the amount required. The machine is entirely automatic in action, thus eliminating the human element. They also exhibited the "Avery Brinell" hardness testing machine, the 129 ft.-lb. impact tester, the 604 cement tester, and a 10 ton machine.

THE DELTA METAL CO., LTD., of East Greenwich, had many samples of their "Delta" bronzes in the form of rods and bars, shapes and sections, solid and hollow, forgings, stampings, &c. Their No. IV. is largely used to replace steel in general engineering, shipbuilding, mining, sanitary, and other work. In addition they displayed numerous test pieces illustrating the strength, tenacity, and ductility of the various qualities of metals and alloys which they manufacture.

EXPLOSIVES TRADES, LTD., of Cavendish Square, exhibited explosives of every description, detonators, electric fuses, sound and smoke signals, &c. They had, too, an engineering section and one dealing with non-ferrous metals.

THE IGRANIC ELECTRIC CO., LTD., of 147, Queen Victoria Street, London, E.C., displayed a large variety of electric coils for wireless equipments, switches, rheostats of various types, and motor starters; and they had in operation a Telfer crane equipped with a model unit type electric lifting magnet for handling steel bars, plates, pipes, &c,

E. GREEN & SON, LTD., of Wakefield, showed a model of their fuel economizer with flues, working in connection with water tube boilers. These economizers pre-heat the water before going to the boilers by means of waste gases and save from 15% to 20% of the coal.

W. H. BAILEY & CO., LTD., of Manchester, showed, among other things, their "aqua-thruster" steam pump, which requires no skilled attention in handling water containing the solids usually found in mine water.

THE ENGINEERING SUPPLIES CO., of Newcastle-on-Tyne, showed the "Finney" pump. One of its special qualifications, which commends it to mining engineers, is that the water on its passage through the pump passes directly through the valves without entering the cylinder and immediately finds its exit through the discharge. This considerably prolongs the life of the cylinder, pistons, and rods, especially when gritty or corrosive liquids have to be dealt with.

ALLEN WEST & CO., LTD., of Brighton, in conjunction with HERBERT MORRIS, LTD., crane makers, of Loughborough, showed a 36 in. circular lifting magnet, hoisting scrap from a large water tank, the magnet being operated by a contactor controller and master switch. A special "locked" winding is one of its features, by which the magnets may be worked under water without injury.

PETTERS, LTD., and VICKERS-PETTERS, LTD., Westminster, showed their "Semi-Diesel" crude-oil engine. It will burn any kind of crude or residual oil at an extremely low running cost; added to this it can be started in one minute from cold, a desideratum long looked for by mining engineers.

W. H. ALLEN, SON, & CO., LTD., of Bedford, had a great display of ships' fittings, from switches and connectors to oil-driven salvage pumps. These pumps have capacities of 670 to 750 tons of water per hour. The work for which the pumps are adapted is that of raising sunken vessels, large numbers being constructed for the Admiralty. The firm also makes pumps useful in mining and metallurgical operations.

GEORGE KENT, LTD., of High Holborn, among a variety of meters were showing their "Venturi" tube for the measurement of the flow of water and air. Their 1½ in. "Gate" type air meter is suitable for use with rock-drills.

J. & E. HALL, LTD., of Dartford, exhibited a refrigerating machine suitable for many purposes: for instance, for the manufacture of ice and for cooling drinking water and cupboards on passenger vessels, and a CO_2 machine for maintaining a steady temperature in ship's magazines. This firm's refrigerating machines are applicable for the drying and cooling of inlet air in schemes for the ventilation of deep mines.

WERF CONRAD, of Haarlem, had an excellent display, in the Holland Section, of their dredges, demonstrating at a glance the enormous stride that has been made since those built about 150 years ago, of which a model was to be seen in the Historical Section. Their dredges are of interest to both civil and mining engineers.

THE MARION STEAM SHOVEL CO., of Canton, Ohio, had a stall at the exhibition, though their name did not appear in the catalogue. Their shovels can be used in an iron mine or for making a railway track. Their small revolving shovel, turning in its own length, can go anywhere, being mounted on crawling traction trucks. The small type can be used for underground mining of all kinds where the head-room suffices. By contrast, Model 100, the working weight of which is 137 tons, has a capacity of from 2,500 to 5,500 cubic yards in ten hours.

THE DETAIL ENGINEERING CO., of Victoria Street, Westminster, were showing a very effective grip for wire rope called the "Mortimer" patent wire rope grip. The whole mechanism consists of two bridges held together by two bolts, with a centre bore having a gripping surface of machined grooves. It is made of forged steel, is plastic, and has no shearing lines. These grips are guaranteed to hold a rope round a standard thimble without reducing the breaking strain more than 5%, and requires a minimum "tail."

METAL MARKETS

COPPER.—The stocks of copper held in this country by the Government on October 1 amounted to 22,784 tons, which showed a decrease on the month of 5,265 tons. While this decrease was satisfactory from a market point of view, it had no material effect on the trend of values, the fact that there would be a decrease being generally expected. Perhaps the most interesting inference that can be drawn is that the Government had apparently been getting a large share of the business which had been going. The market has seen some variations of sentiment during the month of October, which have been chiefly traceable to the fears of, or results of, labour troubles both at home and abroad. One of the most important features has been the downward tendency of the quotations cabled from America, and it seems clear that the large producers there are now shading their prices in spite of much talk

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

	Copper				
	Standard Cash	Standard (3 mos)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
Oct.	£ s. d. £ s. d	£ s. d. £ s. d	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
13	106 10 0 to 107 0 0	106 10 0 to 107 0 0	114 0 0 to 121 0 0	120 0 0 to 121 0 0	113 0 0 to 114 0 0
14	106 0 0 to 106 10 0	105 5 0 to 106 10 0	115 0 0 to 122 0 0	120 0 0 to 122 0 0	114 0 0 to 115 0 0
15	105 15 0 to 106 0 0	106 5 0 to 106 10 0	115 0 0 to 122 0 0	120 0 0 to 122 0 0	114 0 0 to 115 0 0
16	105 5 0 to 105 10 0	105 10 0 to 105 15 0	116 0 0 to 122 0 0	120 0 0 to 122 0 0	114 0 0 to 115 0 0
17	106 5 0 to 106 10 0	106 5 0 to 106 10 0	117 0 0 to 122 0 0	120 0 0 to 122 0 0	115 0 0 to 116 0 0
20	107 5 0 to 107 10 0	106 5 0 to 106 10 0	117 0 0 to 121 0 0	120 0 0 to 121 0 0	115 0 0 to 116 0 0
21	106 5 0 to 106 10 0	105 15 0 to 106 0 0	117 0 0 to 122 0 0	120 0 0 to 122 0 0	115 0 0 to 116 0 0
22	104 10 0 to 104 15 0	104 0 0 to 104 5 0	116 0 0 to 121 0 0	119 0 0 to 121 0 0	115 0 0 to 116 0 0
23	102 5 0 to 102 10 0	102 5 0 to 102 10 0	115 0 0 to 120 0 0	118 0 0 to 120 0 0	115 0 0 to 116 0 0
24	100 10 0 to 100 15 0	100 15 0 to 101 0 0	114 0 0 to 119 0 0	118 0 0 to 119 0 0	113 0 0 to 114 0 0
27	98 5 0 to 98 10 0	99 0 0 to 99 5 0	114 0 0 to 118 0 0	117 0 0 to 118 0 0	113 0 0 to 114 0 0
28	99 2 6 to 99 5 0	99 15 0 to 100 0 0	114 0 0 to 118 0 0	117 0 0 to 118 0 0	113 0 0 to 114 0 0
29	100 0 0 to 100 5 0	100 15 0 to 101 0 0	114 0 0 to 118 0 0	117 0 0 to 118 0 0	113 0 0 to 114 0 0
30	100 12 6 to 100 17 6	101 7 6 to 101 10 0	114 0 0 to 119 0 0	117 0 0 to 119 0 0	113 0 0 to 114 0 0
31	100 10 0 to 100 15 0	101 7 6 to 101 10 0	114 0 0 to 118 0 0	116 0 0 to 118 0 0	113 0 0 to 114 0 0
Nov.					
3	99 15 0 to 100 0 0	100 10 0 to 100 15 0	114 0 0 to 118 0 0	116 0 0 to 118 0 0	113 0 0 to 114 0 0
4	99 10 0 to 99 15 0	100 5 0 to 100 10 0	114 0 0 to 118 0 0	116 0 0 to 118 0 0	112 0 0 to 113 0 0
5	100 12 6 to 100 17 6	101 12 6 to 101 17 6	113 0 0 to 117 0 0	116 0 0 to 117 0 0	112 0 0 to 113 0 0
6	100 15 0 to 101 0 0	102 0 0 to 102 5 0	113 0 0 to 117 0 0	116 0 0 to 117 0 0	112 0 0 to 113 0 0
7	100 5 0 to 100 10 0	101 10 0 to 101 15 0	113 0 0 to 117 0 0	116 0 0 to 117 0 0	112 0 0 to 113 0 0
10	100 0 0 to 100 5 0	101 5 0 to 101 10 0	112 0 0 to 117 0 0	115 0 0 to 117 0 0	112 0 0 to 113 0 0

in the past as to their faith in the future of the metal. It looks as if stocks there were undoubtedly accumulating, and this has no doubt influenced their action. Toward the end of the month the general labour unsettlement in America had a depressing effect on sentiment, although it really seems to be as much a bull point as a bear point, owing to the fact that if consumption is stopped so also will be production. The future absorbing power of the domestic market in America must depend largely on how soon labour there settles down. On this side manufacturers of copper, and of wire, have been very busy, but the brass trade has been affected by the moulders' strike, and the amount of copper going into consumption in this country is probably not up to previous records owing to the difficulty of keeping up output for various reasons, such as lack of fuel and labour. Meanwhile standard copper has been moderately active, some metal being taken up for shipment to Japan and elsewhere, and this was instrumental in creating occasionally a premium for cash standard. Generally speaking standard copper is not dear, and although easier values may be seen for electrolytic in view of the wide margin between the two, standard ought not to be adversely affected.

Average prices for cash standard copper: October 1919, £103. 11s.; September 1919, £100. 17s. 5d.; October 1918, £122. 5s.; September 1918, £122. 5s.

TIN.—This metal has perhaps not been quite so interesting during the month of October, as although values continually fluctuated, the price movements have not been so extravagant as is sometimes the case in this metal. The trade, however, has had a good many vicissitudes during the period in question, with the railway strike and the moulders' strike at home, the steel strike in America, and latterly the labour disturbance in that country. The tinplate trade in this country has been very active, and a good outlet for the metal in that direction seems assured for some time to come. The export demand for America has been rather disappointing, but the lack of business with that country is of course explained by the labour troubles there. When these are over there ought to be a good demand from the United States also, but at the moment it is impossible to say when this can be expected to come along. Meanwhile stocks here have been increasing, and if some time is going to elapse before shipments on an important scale can be resumed to America, it looks as if the supplies in this country must accumulate further. In view of all these circumstances, it can only be said that values have been very well maintained, which may be partly attributable to the firm attitude adopted by holders in the Straits. Latterly little business has been reported from there, and in some quarters it is suggested that holders are finding some less obvious method of disposing of their metal. China continues to refrain from offering, and indeed has been reported to be buying in the Straits. Meanwhile Batavia has been firm and it is reported that Germany has purchased 3,000 tons of Banka tin there. At home, makers of English have not been pressing their metal for sale, as they sold fairly well some time ago when the export buying movement was on, and indeed even yet have difficulty in giving prompt delivery.

Average prices of cash standard tin; October 1919, £279. 4s. 11d.; September 1919, £280. 4s.; October 1918, £335. 10s.; September 1918, £343. 19s. 1d.

LEAD.—This market has seen a considerable advance during the month of October, and dealings on 'Change have surpassed all previous records in their magnitude. The chief cause of this seems to have been the steady reduction in the Government stocks of the metal, and to the fact that there was an absence of serious outside competition from such sources as America. In consequence of this, speculators took a very active interest in the market, and bought largely, with the result that prices very quickly advanced. The firmer aspect of prices brought in consumers' demand, with the result that the market was assisted upward still further. Latterly a little more hesitation has been seen and consumers have been less keen on buying. The chief demand from users emanated from the cable makers, who have been very busy and have bought well forward, but it is also reported that there is an improvement in the sheet and pipe trade. The market now appears to be in the neighbourhood of such a level as might induce the United States to offer bonded lead to this country, and this would of course have the effect of preventing a further advance. Business, indeed, has already been reported to have been done by America

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			Oct.
27 15 0 to 29 0 0	29 0 0	43 10 0 to 44 10 0	283 10 0 to 283 15 0	284 10 0 to 285 0 0	$62\frac{3}{4}$	62	13
28 10 0 to 29 5 0	29 10 0	43 15 0 to 44 10 0	281 10 0 to 281 15 0	282 15 0 to 283 5 0	$63\frac{1}{16}$	$62\frac{5}{16}$	14
28 12 6 to 29 5 0	29 10 0	44 0 0 to 44 15 0	278 15 0 to 279 0 0	280 0 0 to 280 5 0	$63\frac{3}{4}$	63	15
28 15 0 to 29 5 0	29 15 0	44 5 0 to 44 17 6	279 15 0 to 280 0 0	280 15 0 to 281 0 0	$63\frac{3}{4}$	$62\frac{7}{8}$	16
28 17 6 to 29 5 0	29 15 0	44 10 0 to 45 0 0	281 0 0 to 281 5 0	282 5 0 to 282 10 0	$63\frac{3}{4}$	$62\frac{7}{8}$	17
29 0 0 to 29 10 0	30 0 0	45 0 0 to 45 10 0	281 10 0 to 282 0 0	282 10 0 to 283 0 0	$64\frac{1}{4}$	$63\frac{1}{4}$	20
29 5 0 to 29 15 0	30 5 0	45 10 0 to 46 0 0	281 0 0 to 281 5 0	282 0 0 to 282 5 0	$64\frac{3}{4}$	$63\frac{5}{8}$	21
29 12 6 to 30 5 0	30 10 0	45 10 0 to 45 15 0	279 0 0 to 279 5 0	280 0 0 to 280 5 0	$63\frac{3}{4}$	$63\frac{1}{16}$	22
30 10 0 to 31 5 0	31 10 0	45 10 0 to 45 15 0	280 0 0 to 280 5 0	281 0 0 to 281 5 0	$63\frac{7}{8}$	$63\frac{1}{8}$	23
30 7 6 to 30 17 6	31 10 0	45 10 0 to 45 15 0	279 0 0 to 279 5 0	280 0 0 to 280 5 0	$64\frac{1}{4}$	$63\frac{5}{8}$	24
29 17 6 to 30 17 6	31 5 0	45 0 0 to 45 10 0	273 10 0 to 273 15 0	274 10 0 to 274 15 0	65	$64\frac{3}{16}$	27
30 7 6 to 30 15 0	31 5 0	45 0 0 to 45 5 0	275 15 0 to 276 0 0	277 0 0 to 277 5 0	$65\frac{3}{8}$	$64\frac{3}{16}$	28
30 10 0 to 30 15 0	31 5 0	44 10 0 to 45 0 0	276 15 0 to 277 0 0	277 15 0 to 278 0 0	$66\frac{1}{2}$	$64\frac{3}{4}$	29
30 15 0 to 31 0 0	31 10 0	43 10 0 to 44 0 0	277 5 0 to 277 10 0	278 0 0 to 278 5 0	$66\frac{1}{2}$	$64\frac{11}{16}$	30
31 2 6 to 31 7 6	32 0 0	44 10 0 to 45 0 0	275 0 0 to 275 5 0	275 10 0 to 275 15 0	$65\frac{1}{2}$	$63\frac{3}{4}$	31
							Nov.
32 0 0 to 32 7 6	33 0 0	44 10 0 to 45 0 0	272 15 0 to 273 0 0	273 10 0 to 273 15 0	66	$63\frac{1}{2}$	3
32 10 0 to 32 15 0	33 10 0	44 15 0 to 45 5 0	273 15 0 to 274 0 0	274 5 0 to 274 10 0	67	$64\frac{1}{2}$	4
33 0 0 to 33 5 0	34 0 0	44 15 0 to 45 5 0	277 0 0 to 277 5 0	277 5 0 to 277 10 0	$66\frac{3}{4}$	64	5
53 5 0 to 33 10 0	34 0 0	44 10 0 to 45 0 0	279 0 0 to 279 5 0	279 0 0 to 279 5 0	$66\frac{3}{4}$	64	6
33 10 0 to 33 15 0	34 10 0	44 15 0 to 45 10 0	278 10 0 to 278 15 0	278 15 0 to 279 0 0	$66\frac{3}{4}$	$64\frac{1}{2}$	7
33 12 6 to 33 17 6	34 10 0	44 15 0 to 45 15 0	279 5 0 to 279 10 0	279 10 0 to 279 15 0	$68\frac{7}{8}$	67	10

in France, but on the other hand it is stated that the consumption in America is such as would not leave metal available for export. The labour troubles there may change the aspect of affairs in this connection.

Average prices of soft pig lead: October 1919, £28. 15s. 11d.; September 1919, £25. 12s. 7d.; October 1918, £29; September 1918, £29.

SPELTER.—This market has also advanced considerably and business on the Metal Exchange has been very active indeed. The galvanized sheet trade has been busy, and a good demand has been experienced from time to time with consumers, which no doubt was responsible for a certain amount of covering being done on 'Change, but at the same time a large factor in the operations there has been purchases on account of speculators, who appear to consider the position of the article favourable and were determined to have the benefit of any rise. The American market, on the other hand, had for a while an easy tone, due to the steel strike there, and this made business possible with that country. As a result the demand on 'Change was met more freely and the advance was stayed. Some of the buying on this side is attributed to American sources, possibly with the object of firming-up values. Meanwhile consumers have been pretty well covered, and it looks as if, when re-sales come on the market, a reaction might be seen. Recently some offerings here of German spelter have been reported, but it does not seem probable that the quantities from that source will be sufficient to influence the position. At the time of writing there is still no announcement as to the policy to be pursued in regard to the English smelting works when the existing subsidy arrangement expires early in November.

Average prices of spelter: October 1919, £43. 18s.; September 1919, £41. 8s. 5d.; October 1918, £52; September 1918, £52.

ZINC DUST.—Supplies have been rather scarce and prices firm. Australian high grade (88 to 92% metallic zinc) has been raised to £75 per ton c.i.f. U.K.

ANTIMONY.—This article has been firm, and prices have been advanced to £47. 10s. for English regulus. Some business has been done in Chinese for prompt shipment from the East at £45 c.i.f. U.K.

ARSENIC.—This market has been firm, and the quotation for white delivered London is about £62 per ton.

BISMUTH.—12s. 6d. nominal per lb.

CADMIUM.—6s. 6d. to 6s. 9d. per lb.

ALUMINIUM.—£150 per ton for the home trade.

NICKEL.—£205 per ton for the home trade, and £210 for export.

COBALT METAL.—10s. 6d. per lb.

COBALT OXIDE.—7s. to 8s. per lb.

PLATINUM.—450s. nominal per oz.

PALLADIUM.—500s. nominal per oz.

QUICKSILVER.—£17. 5s. to £17. 10s. per bottle.

SELENIUM.—12s. to 15s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER.—£41 to £43 per ton.

MANGANESE ORE.—Firm at about 2s. 3d. per unit for Indian c.i.f. U.K.

TUNGSTEN ORES.—Wolframite 65% and scheelite 65%, 32s. 6d. per unit.

MOLYBDENITE.—85%, 75s. to 80s. per unit.

SILVER.—The market has fluctuated slightly, but in the main has been very strong, chiefly on Chinese buying, and prices of standard bars touched the record high level of 66½d. per oz. Early in November the record price of 68⅞d. was reached.

CORUNDUM.—No quotation.

GRAPHITE.—80%, £35 to £40 per ton c.i.f. U.K.

CHROME ORES.—No quotation.

IRON & STEEL.—The predominant feature of the Cleveland pig iron market has been the scarcity of foundry iron. It was hoped that this might be to some extent remedied by the moulders' strike, which would permit of some of the export inquiries being satisfied in view of the consequent reduction in home consumption. Unfortunately the interruption of the work of the blast-furnaces by reason of the railway strike somewhat defeated hopes in this respect. As it is, although the moulders' strike was prolonged, there is still a shortage of foundry iron. Prices are steady, but the rise in railway rates, which seems inevitable, will of course affect these. As regards manufactured iron and steel, works are all very busy, operations being thrown into arrears by the railway strike, while there is still an active demand for both home and export account, and ship plates, for example, are very difficult to procure

STATISTICS.

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand	Else-where	Total	Value
	Oz.	Oz.	Oz.	£
July, 1918	716 010	20,189	736,199	3,127,174
August	719,849	20,361	740,210	3,144,211
September	686,963	21,243	708,206	3,008,267
October	667,955	11,809	679,764	2,887,455
November	640,797	17,904	658,701	2,797,983
December	630,505	10,740	641,245	2,723,836
Year 1918	8,197,959	221,734	8,419,693	35,768,688
January, 1919	662,205	13,854	676,059	2,871,718
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,199	698,558	2,967,287

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1918	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	196,294
September 30	179,399	12,108	4,889	196,395
October 31	173,153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637
January 31, 1919	160,599	11,848	3,539	175,986
February 28	172,359	11,868	4,264	188,491
March 31	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806

COST AND PROFIT ON THE RAND.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d	s. d	s. d.	£
July, 1918	2,167,869	27 10	21 2	6 6	702,360
August	2,158,431	28 1	21 7	6 6	676,146
September	2,060,635	28 2	22 0	5 10	600,330
October	2,015,144	28 0	22 5	5 3	551,774
November	1,899,925	28 5	23 1	5 1	480,102
December	1,855,991	28 7	23 0	5 6	507,860
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129
January, 1919	1,942,329	28 9	23 0	5 8	547,793
February	1,816,352	28 9	23 2	5 6	498,204
March	2,082,469	28 0	22 6	5 6	573,582
April	1,993,652	28 7	22 9	5 9	573,143
May	[illegible]	28 4	22 3	5 10	608,715
June	2,032,169	28 4	22 4	5 10	592,361
July	2,134,068	27 10	21 9	6 9	611,118
August	2,036,128	28 5	22 11	5 5	551,203

PRODUCTION OF GOLD IN RHODESIA AND WEST AFRICA.

	RHODESIA.		WEST AFRICA.	
	1918	1919	1918	1919
	£	£	£	£
January	253,807	211,917	107,863	104,063
February	232,023	220,885	112,865	112,616
March	230,023	225,808	112,605	112,543
April	239,916	213,160	117,520	109,570
May	239,205	218,057	126,290	100,827
June	225,447	214,215	120,273	106,612
July	251,740	214,919	117,581	102,467
August	257,096	207 339	120,526	103,112
September	247,885	223,719	115,152	100,401
October	136,780	—	61,461	—
November	145,160	—	108,796	—
December	192,870	—	112,081	—
Total	2,652,250	1,950,029	1,333,553	952,211

TRANSVAAL GOLD OUTPUTS.

	September, 1919	
	Treated	Value
	Tons	£
Aurora West	13,700	14,949
Bantjes	—	—
Barrett	—	216
Brakpan	41,500	81,205
City & Suburban	21,777	30,820
City Deep	57,000	105,683
Cons. Langlaagte	43,000	53,720
Cons. Main Reef	45,100	72,474
Crown Mines	176,000	244,312
Durban Roodepoort Deep	20,400	27,778
East Rand P.M.	126,000	149,131
Ferreira Deep	32,500	47,988
Geduld	42,500	64,205
Geldenhuis Deep	42,900	51,268
Ginsberg	—	—
Glynn's Lydenburg	2,770	4,617
Goch	13,800	10,719
Government G.M. Areas	113,000	201,740
Heriot	11,350	14,595
Jupiter	25,000	27,099
Kleinfontein	44,740	65,586
Knights Central	20,000	25,143
Knights Deep	56,400	70,563
Langlaagte Estate	40,200	48,775
Luipaard's Vlei	20,110	19,041
Meyer & Charlton	14,442	40,068
Modderfontein	67,500	153,519
Modderfontein B	55,500	115,715
Modderfontein Deep	42,500	94,596
New Unified	11,300	11,673
Nourse	37,250	47,588
Primrose	17,100	17,132
Princess Estate	20,000	25,879
Randfontein Central	150,000	174,378
Robinson	40,700	41,616
Robinson Deep	54,200	76,396
Roodepoort United	23,100	23,254
Rose Deep	50,900	58,147
Simmer & Jack	52,600	59,038
Simmer Deep	49,000	51,505
Springs	36,550	53,194
Sub Nigel	9,900	26,713
Transvaal G.M. Estates	15,210	23,636
Van Ryn	30,700	[illegible]
Van Ryn Deep	53,500	[illegible]
Village Deep	43,600	61,673
Village Main Reef	17,200	24,681
West Rand Consolidated	30,400	38,261
Witwatersrand (Knights)	32,650	37,733
Witwatersrand Deep	27,240	32 620
Wolhuter	27,200	35,652

WEST AFRICAN GOLD OUTPUTS.

	September, 1919	
	Treated	Value
	Tons	£
Abbontiakoon	7,028	14,837
Abosso	6,940	12,472
Ashanti Goldfields	7,562	8,498
Ofin River	—	—
Prestea Block A	14,580	24,018
Taquah	4,471	11,838
Wassau	—	—

RHODESIAN GOLD OUTPUTS.

	September, 1919	
	Treated	Value
	Tons	£
Antelope	3,110	5,203
Cam & Motor	—	—
Eldorado Banket	—	—
Falcon	15,106	23,878*
Gaika	3,189	5,551
Globe & Phœnix	5,012	6,059†
Lonely Reef	4,560	25 576
Rezende	4,000	10,700
Rhodesia, Ltd.	397	1,057
Shamva	52,534	36,782
Transvaal & Rhodesian	1,700	4,400
Wanderer	—	—

* Gold, Silver and Copper; † Ounces Gold.

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
November, 1918	1,444	70,711	72,155	306,494
December	2,739	61,314	64,053	272,208
January, 1919	*	69,954	*	*
February	733	66,310	67,043	281,779
March	*nil*	66,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316,862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535

* By direction of the Federal Government the export figures were not published. † Figures not received.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1918	1919	1918	1919	1918	1919
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	25,000	18,000
February	58,113	46,955	45,470	43,330	28,000	24,000
March	65,412	40,267	48,020	48,000	30,000	16,000
April	29,620	63,818	47,600	61,200	30,000	24,000
May	87,885	37,456	46,740	38,200	45,000	16,000
June	45,765	41,465	51,420	44,600	32,000	17,000
July	64,347	37,395	51,000	42,060	25,000	22,000
August	61,163	—	44,600	49,700	21,000	20,000
September	65,751	—	45,900	37,120	32,000	13,000
October	*	—	54,400	—	40,000	—
November	*	—	38,200	—	25,000	—
December	70,674	—	56,281	—	38,000	—
Total	674,655	304,292	578,213	401,310	370,000	170,000

* Figures not received.

Australasian Gold Outputs.

	September, 1919	
	Treated Tons	Value £
Associated	4,702	7,203
Associated Northern Blocks { Iron Duke	—	1,672*
Associated Northern Blocks { Victorious	—	—
Blackwater	2,225	4,141
Bullfinch	5,610	5,518
Golden Horseshoe	13,860	30,388
Great Boulder Prop.	9,523	27,661
Ivanhoe	17,027	27,400
Kalgurli	3,184	7,061
Lake View & Star	8,566	10,708
Mount Boppy	8,266	8,500
Oroya Links	1,397	9,450†
Progress	1,350	1,961
Sons of Gwalia	13,557	18,665
South Kalgurli	5,523	8,713
Talisman	—	—
Waihi	15,152	25 001‡
Waihi Grand Junction	5,500	7,976‡

* Surplus; † Total receipts; ‡ Gold and Silver to October 4.

Miscellaneous Gold Output.

	September, 1919	
	Treated Tons	Value £
Barramia (Sudan)	—	—
Esperanza (Mexico)	—	—
Frontino & Bolivia (Colombia)	2,660	10,016
Nechi (Colombia)	88,591*	31,702
Ouro Preto (Brazil)	6,600	2,505
Pato (Colombia)	134,737*	82,037†
Philippine Dredges (Philippine Islands)	—	—
Plymouth Cons. (California)	8,000	11,150
St. John del Rey (Brazil)	—	33,000
Santa Gertrudis (Mexico)	32,775	32,980††
Sudan Gold Field (Sudan)	—	—

* Cubic yards. † Dollars. § Ounces, fineness not stated.
†† Profit, gold and silver.

Production of Gold in India.

	1916	1917	1918	1919
	£	£	£	£
January	192,150	190,047	176,030	161,270
February	183,264	180,904	173,343	153,775
March	186,475	189,618	177,950	162,790
April	192,208	185,835	176,486	162,550
May	193,604	184,874	173,775	164,080
June	192,469	182,426	174,375	162,996
July	191,404	179,660	171,950	163,795
August	192,784	181,005	172,105	160,540
September	192,330	183,630	170,360	156,450
October	191,502	182,924	167,740	—
November	192,298	182,388	157,176	—
December	205,164	190,852	170,630	—
Total	2,305,652	2,214,163	2,061,920	1,351,546

Indian Gold Outputs.

	September, 1919	
	Tons Treated	Fine Ounces
Balaghat	3,050	1,999
Champion Reef	11,510	6,848
Hutti (Nizam's)	—	750
Jibutil	—	—
Mysore	20,065	12,502
North Anantapur	800	1,078
Nundydroog	8,323	6,263
Ooregum	12,800	7,373

Base Metal Outputs

		September 1919
Arizona Copper	Short tons copper	—
British Broken Hill	Tons lead concentrate	—
British Broken Hill	Tons zinc concentrate	—
British Broken Hill	Tons carbonate ore	—
Broken Hill Block 10	Tons lead concentrate	—
Broken Hill Block 10	Tons zinc concentrate	—
Burma Corp.	Tons refined lead	1,181
Burma Corp.	Oz. refined silver	136,938
Cordoba Copper		—
Fremantle Trading	Long tons lead	—
North Broken Hill	Tons lead	—
North Broken Hill	Oz. silver	—
Poderosa	Tons copper ore	230
Rhodesian Broken Hill	Tons lead and zinc	—
Tanganyika	Long tons copper	2,014
Tolima	Tons silver-lead concentrate	—
Zinc Corp.	Tons zinc concentrate	—
Zinc Corp.	Tons lead concentrate	—

Imports of Ores and Metals into United Kingdom.

		Oct. 1919	Year 1919
Iron Ore	Tons	368,563	4,493,188
Manganese Ore	Tons	9,827	242,095
Copper and Iron Pyrites	Tons	47,979	278,4[illegible]
Copper Ore	Tons	856	11,354
Copper Precipitate	Tons	2,168	11,675
Copper Metal	Tons	7,465	98,915
Tin Concentrate	Tons	4,559	30,398
Tin Metal	Tons	4,644	19,328
Lead, Pig and Sheet	Tons	18,118	202,435
Zinc (Spelter)	Tons	6,470	79,796
Quicksilver	Lb.	84,000	2,608,719
Zinc Oxide	Cwt.	5 070	114,228
Barytes	Cwt.	30,380	354,861
Phosphate	Tons	30,100	290,105
Brimstone	Cwt.	12,256	128,031
Boracic Compounds	Cwt.	48,618	255,383
Nitrate of Potash	Cwt.	19,939	143,818
Petroleum:			
Crude	Gallons	2,710,815	7,577,549
Lamp Oils	Gallons	10,827,861	134,093,208
Motor Spirit	Gallons	20,069,037	[illegible]
Lubricating Oils	Gallons	6,046,447	52,766,421
Gas Oil	Gallons	3,035,960	20,565,478
Fuel Oil	Gallons	27,404,157	213,472,594
Total Petroleum	Gallons	70,482,801	691,488,803

UNITED STATES METAL EXPORTS AND IMPORTS.

Exports.	June Tons.	July Tons.	Imports.	June Tons.	July Tons.
Copper Ingots	10,826	18,917	Antimony	722	645
Copper Tubes	248	149	Tin Con.	—	1,975
Copper Sheets	229	195	Tin	50	897
Copper Wire	2,127	2,468	Manganese Ore	31,550	15,585
Lead, Pig	7,492	2,367	TungstenCon	338	452
Zinc	10,730	8,842	Pyrites	50,545	63,088
Zinc Sheets	746	896			

OUTPUTS OF TIN MINING COMPANIES.
In Tons of Concentrate.

	Year 1918 Tons	Sept. 1919 Tons	Year 1919 Tons
Nigeria:			
Abu	33	1	16
Anglo-Continental	207	6	117
Associated Nigerian	—	40	80
Benue	146	3	59
Berrida	—	–	1
Bisichi	275	28	141
Bongwelli	17	6	43
Dua	60	5	50
Ex-Lands	342	30	170
Filani	37	5	25
Forum River	274	15	125
Gold Coast Consolidated	30	3	27
Gurum River	99	8	81
Jantar	141	8	81
Jos	228	11	159
Kaduna	178	12	141
Kaduna Prospectors	—	6	47
Kano	60	8	114
Kassa-Ropp	133	–	84
Keffi	118	–	30
Kuru	12	16	209
Kuskie	21	2	4
Kwall	108	–	7
Lower Bisichi	99	5	60
Lucky Chance	27	2	23
Minna	40	4	30
Mongu	476	45	402
Naraguta	478	49	302
Naraguta Extended	280	30	199
New Lafon	198	–	125
Nigerian Tin	87	–	25
Ninghi	—	6	40
N.N. Bauchi	435	42	282
Offin River	120	–	40
Rayfield	689	41	488
Ropp	836	85	784
Rukuba	132	6	35
South Bukeru	94	3	38
Sybu	40	1	23
Tin Areas	96	7	57
Tin Fields	108	15	129
Toro	17	–	3
Union & Rhodesian Trust	—	6	6
Federated Malay States:			
Chenderiang	179	145	197
Gopeng	979	51	608
Idris Hydraulic	136	15	163
Ipoh	245	14	121
Kamunting	236	72	168
Kinta	478	39	330
Kledang	28	–	10
Lahat	399	42	328
Malayan Tin	730	39	481
Pahang	1,877	184	1,626
Rambutan	207	15	120
Sungei Besi	408	39	295
Tekka	508	36	335
Tekka-Taiping	400	27	243
Tronoh	1,364	121	1,107
Tronoh South	133	–	–
Cornwall:			
Cornwall Tailings	140	–	–
Dolcoath	787	60	554
East Pool	1,336	70	750
Geevor	392	–	186
South Crofty	598	43	426
Other Countries:			
Aramayo Francke (Bolivia)	1,816	–	1,397
Briseis (Tasmania)	327	15	172
Deebook (Siam)	398	20	210
Mawchi (Burma)	658	51	572
Porco (Bolivia)	227	–	186
Renong (Siam)	615	22	641
Rooiberg Minerals (Transvaal)	335	13	209
Siamese Tin (Siam)	989	74	456
Tongkah Harbour (Siam)	1,528	107	881
Zaaiplaats (Transvaal)	563	12	235

NIGERIAN TIN PRODUCTION.
In long tons of concentrate of unspecified content.
***Note** These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.*

	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	485	417	531	667	678	613
February	469	358	528	646	668	623
March	502	418	547	655	707	606
April	482	444	486	555	584	546
May	480	357	536	509	525	483
June	460	373	510	473	492	484
July	432	455	506	479	545	481
August	228	438	498	551	571	616
September	289	442	535	538	520	557
October	272	511	584	578	491	—
November	283	467	679	621	472	—
December	326	533	654	655	518	—
Total	4,708	5,213	6,594	6,927	6,771	5,003

TOTAL SALES OF TIN CONCENTRATE AT REDRUTH TICKETINGS.

	Long tons	Value	Average
July 1	170½	£34,035	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	146¼	£33,816	£231 4 6
August 12	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	142½	£28,793	£202 1 2
September 24	145¾	£29,639	£203 7 2
October 7	136½	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	141½	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	165¾	£25,170	£150 19 0
December 16	175½	£26,032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918	4,094	£786 541	£192 0 0
January 13, 1919	160	£20,838	£130 11 0
January 27	135½	£17,000	£125 10 7
February 10	153	£17,441	£113 19 10
February 24	142	£15,015	£105 14 10
March 10	144½	£18,123	£125 8 5
March 24	148½	£17 877	£120 7 8
April 7	134½	£15,258	£111 8 10
April 22	134¼	£15,023	£111 18 1
May 5	129	£14,919	£115 13 2
May 19	126½	£15,844	£125 5 0
June 2	140	£17,185	£122 15 0
June 16	139	£17,206	£123 15 9
June 30	136	£16,782	£123 8 0
July 14	145	£18,250	£125 17 3
July 28	122	£16,939	£138 16 11
August 11	127½	£17,125	£134 6 5
August 25	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0

DETAILS OF REDRUTH TIN TICKETINGS.

	October 8		October 20	
	Tons Sold	Realized per ton £ s. d	Tons Sold	Realized per ton £ s. d.
E. Pool & Agar, No. 1	12	151 15 0	—	—
" " No. 1a	12	151 15 0	—	—
" " No. 1b	11	150 0 0	—	—
" " No. 1c	—	—	—	—
Dolcoath, No. 1	—	—	—	—
" No. 1a	-	—	—	—
" No 1b	—	—	—	—
" No. 2	—	—	—	—
" A	—	—	—	—
South Crofty, No. 1	—	—	—	—
" " No. 1a	–	—	—	—
Grenville Utd., No. 1	8	147 15 0	6	148 15 0
" " No. 1a	2	74 2 6	—	—
" " No. 2	—	—	—	—
Tincroft Mines, No. 1	6	158 12 6	5	164 7 6
" " No. 1a	6	160 0 0	6	164 10 0
Levant Mines, No. 1	8	155 10 0	8	158 15 0
" " No. 1a	7	157 0 0	7	160 5 0
Total	72		32	

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons. *Figures not published.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January ...	4,395	4,316	3,558	3,149	3,765
February ...	3,780	3.372	2,755	3.191	2,673
March	3,653	3,696	3,286	2,608	2,819
April	3,619	3,177	3,251	3,308	2,855
May	3,823	3.729	3,413	3.332	3,404
June	4,048	3,435	3,489	2,950	2,873
July	3,544	3,517	3,253	3,373	3,756
August	4,046	3,732	3,413	3,259	2.955
September .	3,932	3,636	3,154	3,166	3,161
October......	3,797	3,681	3,436	2,870	—
November .	4,059	3,635	3,300	3,131	—
December .	4,071	3,945	3,525	3,023	—
	46.767	43,871	39,833	37.370	28,261

Stocks of Tin

Reported by A. Strauss & Co. Long Tons.

	Sept. 30, 1919	Oct. 31, 1919
	Tons	Tons
Straits and Australian Spot	523	2,515
Ditto, Landing and in Transit...........	2,522	1,235
Other Standard, Spot and Landing ...	275	1,900
Straits, Afloat....................................	3,585	1,390
Australian, Afloat..............................	225	178
Banca, in Holland..............................	1,370	1,000
Ditto, Afloat	2,293	775
Billiton, Spot	—	—
Billiton, Afloat	70	49
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	2,071	276
Total Afloat for United States...........	8,542	5,929
Stock in America	1,515	7,560
Total	21,292	22,807

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	Sept. 1919	Oct. 1919
	Tons	Tons
Shipments from:		
Straits to U.K.	1,500	1,060
Straits to America	3,615	3,070
Straits to Continent..................	350	301
Straits to Other Places	742	341
Australia to U.K.	350	250
U.K. to America	1,369	1,479
Imports of Bolivian Tin into Europe...	29	1,819
Supply:		
Straits	5,465	4,431
Australian	350	250
Billiton	47	—
Banca	1,557	—
Standard	1,494	1,267
Consumption:		
U K. Deliveries.......................	1,142	1,650
Dutch ,, ...	54	1,137
American ,, ...	4,825	2,875
Straits, Banca & Billiton, Continental Ports, etc.	917	375
Straits in hands of Malay Government	—	—
,, controlled by U.S. Government	—	—
,, ,, ,, French and Italian Governments..............................	—	—
Banca in Trading Company's hands ...	—	—

PRICES OF CHEMICALS. November 7.

		£	s.	d.
Alum	per ton	17	0	0
Alumina, Sulphate of	,,	17	0	0
Ammonia, Anhydrous...............	per lb.		2	0
,, 0·880 solution	per ton	33	0	0
,, Carbonate	per lb.			6½
,, Chloride of, grey......	per ton	47	0	0
,, ,, ,, pure......	per cwt.	4	0	0
,, Nitrate of	per ton	60	0	0
,, Phosphate of............	,,	110	0	0
,, Sulphate of	,,	19	0	0
Antimony Sulphide	per lb.		1	3
Arsenic, White..........................	per ton	60	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	55	0	0
Bleaching Powder, 35% Cl.	,,	17	0	0
Borax	,,	39	0	0
Copper, Sulphate of	,,	41	0	0
Cyanide of Sodium, 100%.........	per lb.			11
Hydrofluoric Acid	,,			7
Iodine..	,,		16	0
Iron, Sulphate of......................	per ton	4	10	0
Lead, Acetate of, white	,,	83	0	0
,, Nitrate of	,,	56	0	0
,, Oxide of, Litharge	,,	46	0	0
,, White	,,	50	0	0
Lime, Acetate, brown.............	,,	12	0	0
,, ,, grey 80%............	,,	17	0	0
Magnesite, Calcined	,,	21	10	0
Magnesium Chloride	,,	16	0	0
,, Sulphate...............	,,	12	0	0
Methylated Spirit 64° Industrial	per gal.		5	7
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	,,		1	6
,, Carbonate	per ton	100	0	0
,, Chlorate	per lb.		1	0
,, Chloride 80%	per ton	25	0	0
,, Hydrate (Caustic) 90%	,,	105	0	0
,, Nitrate....................	,,	55	0	0
,, Permanganate	per lb.		3	3
,, Prussiate, Yellow	,,		1	9
,, Sulphate, 90%	per ton	25	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	49	0	0
,, Arsenate 45%.............	,,	60	0	0
,, Bicarbonate	,,	8	10	0
,, Bichromate	per lb.			11
,, Carbonate (Soda Ash)...	per ton	12	10	0
,, ,, (Crystals) ...	,,	5	10	0
,, Chlorate.....................	per lb.			6
,, Hydrate, 76%	per ton	24	0	0
,, Hyposulphite	,,	19	0	0
,, Nitrate, 95%...............	,,	21	0	0
,, Phosphate	,,	28	0	0
,, Prussiate......................	per lb.		1	0
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)......	,,	3	10	0
,, ,, (Glauber's Salts)	,,	4	0	0
,, Sulphide........................	,,	23	0	0
Sulphur, Roll..........................	,,	22	0	0
,, Flowers.......................	,,	22	0	0
Sulphuric Acid, Non-Arsenical... 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%...	,,	5	0	0
Tartaric Acid..........................	per lb.		3	2
Zinc Chloride	per ton	23	10	0
Zinc Sulphate	,,	22	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Nov. 7 1918 £	s.	d.	Nov. 6 1919 £	s.	d.
RAND:						
Brakpan	3	15	0	3	15	0
Central Mining (£8)	7	15	0	10	15	0
City & Suburban (£4)		15	6		10	0
City Deep	2	18	9	3	2	6
Consolidated Gold Fields	2	0	6	2	2	6
Consolidated Langlaagte	1	1	3	1	5	0
Consolidated Main Reef		15	3		12	0
Consolidated Mines Selection (10s.)	1	6	9	1	12	6
Crown Mines (10s.)	2	8	9	3	7	6
Daggafontein	1	5	6	1	3	9
Durban Roodepoort Deep		10	0		10	0
East Rand Proprietary		5	0		7	9
Ferreira Deep		17	0		13	9
Geduld	2	0	0	3	0	0
Geldenhuis Deep		13	0		12	6
Gov't Gold Mining Areas	4	12	6	5	0	0
Heriot		17	6		11	6
Johannesburg Consolidated	1	4	0	1	12	6
Jupiter		5	9		4	9
Kleinfontein		16	0		13	6
Knight Central		5	3		6	3
Knights Deep		10	6		10	0
Langlaagte Estate		19	6		19	6
Meyer & Charlton	4	16	3	4	10	0
Modderfontein (£4)	26	0	0	30	5	0
Modderfontein B	8	5	0	9	0	0
Modder Deep (5s.)	7	13	9	2	6	3*
Modder East		—		1	15	0
Nourse		17	6		15	0
Rand Mines (5s.)	3	5	6	3	12	6
Rand Selection Corporation	4	5	0	4	15	0
Randfontein Central		14	0		19	6
Robinson (£5)		16	6		13	0
Robinson Deep A (1s.)	1	5	0	1	2	6
Rose Deep		18	9		18	9
Simmer & Jack		7	6		7	0
Simmer Deep		3	9		2	9
Springs	3	13	9	2	17	6
Sub-Nigel	1	14	6	1	1	3
Union Corporation (12s. 6d.)		17	6	1	3	6
Van Ryn	1	1	3	1	0	0
Van Ryn Deep	3	10	6	4	10	0
Village Deep	1	0	0		16	0
Village Main Reef		14	0		9	0
Witwatersrand (Knight's)	1	8	9	1	3	9
Witwatersrand Deep		13	3		9	9
Wolhuter		6	6		4	9
OTHER TRANSVAAL GOLD MINES:						
Glynn's Lydenburg	1	3	9		16	3
Sheba (5s.)		1	3		1	9
Transvaal Gold Mining Estates		18	6		16	3
DIAMONDS IN SOUTH AFRICA:						
De Beers Deferred (£2 10s.)	15	17	7	29	0	0
Jagersfontein	4	10	0	7	15	0
Premier Deferred (2s. 6d.)	6	17	6	12	0	0
RHODESIA:						
Cam & Motor		10	6		9	0
Chartered British South Africa	1	1	9	1	3	3
Eldorado		7	0		5	6
Falcon	1	1	3		13	3
Gaika		18	0		16	3
Giant		8	0		9	0
Globe & Phœnix (5s.)	1	10	0		16	0
Lonely Reef	1	17	6	3	5	0
Rezende	4	16	3	4	17	6
Shamva	1	17	0	1	18	9
Willoughby's (10s.)		7	0		6	3
WEST AFRICA:						
Abbontiakoon (10s.)		5	6		4	6
Abosso		7	0		14	6
Ashanti (4s.)	1	0	9	1	4	0
Prestea Block A		4	0		5	9
Taquah		14	6		16	6
WEST AUSTRALIA:						
Associated Gold Mines		3	6		3	3
Associated Northern Blocks		4	0		3	6
Bullfinch		1	6		2	6
Golden Horse-Shoe (£5)	1	18	0	1	7	6
Great Boulder Proprietary (2s.)		11	6		10	0
Great Fingall (10s).		2	0		1	9
Ivanhoe (£5)	1	13	0	2	1	3
Kalgurli		10	6		11	6
Lake View & Oroya (10s.)		14	6	1	4	3
Sons of Gwalia		10	6		7	0
South Kalgurli (10s.)		6	3		5	6

GOLD, SILVER, cont.	Nov. 7 1918 £	s.	d.	Nov. 6 1919 £	s.	d.
OTHERS IN AUSTRALASIA:						
Blackwater, New Zealand		8	9		8	9
Consolidated G.F. of New Zealand		3	9		3	9
Mount Boppy, New South Wales		5	0			9
Progress, New Zealand		2	0		2	0
Talisman, New Zealand		12	0		8	9
Waihi, New Zealand	2	1	3	2	12	6
Waihi Grand Junction, New Z'lnd		17	0		14	0
AMERICA:						
Buena Tierra, Mexico		17	6		15	0
Camp Bird, Colorado		14	6	1	3	0
El Oro, Mexico		13	9		18	6
Esperanza, Mexico		9	9		16	9
Frontino & Bolivia, Colombia		12	6		10	0
Le Roi No. 2 (£5), British Columbia		10	0		11	3
Mexico Mines of El Oro, Mexico	6	9	0	7	17	6
Nechi (Pref. 10s.), Colombia		11	6		12	6
Oroville Dredging, Colombia		19	3	1	8	9
Plymouth Consolidated, California	1	5	0	1	3	9
St. John del Rey, Brazil		19	0		18	9
Santa Gertrudis, Mexico		14	3	1	17	0
Tomboy, Colorado		14	3		16	6
RUSSIA:						
Lena Goldfields	1	17	6	1	11	3
Orsk Priority		15	0		15	0
INDIA:						
Balaghat		5	3		4	9
Champion Reef (2s. 6d.)		6	0		4	3
Mysore (10s.)	2	10	0	1	5	0
North Anantapur		5	6		4	6
Nundydroog (10s.)	1	2	6		17	6
Ooregum (10s.)		17	9		14	3
COPPER:						
Arizona Copper (5s.), Arizona	2	5	0	1	16	3
Cape Copper (£2), Cape Province	2	12	6	2	7	6
Esperanza, Spain		7	6		5	9
Hampden Cloncurry, Queensland	1	10	0		17	9
Kyshtim, Russia	2	0	0	1	12	6
Mason & Barry, Portugal	2	13	9	2	3	9
Messina (5s.), Transvaal		5	0		5	0
Mount Elliott (£5), Queensland	3	5	0	4	5	0
Mount Lyell, Tasmania	1	8	3	1	5	3
Mount Morgan, Queensland	1	11	6	1	2	6
Mount Oxide, Queensland		6	9		8	0
Namaqua (£2), Cape Province	2	5	0	2	0	0
Rio Tinto (£5), Spain	69	0	0	50	10	0
Sissert, Russia	1	3	9	1	2	6
Spassky, Russia	2	2	6	1	18	0
Tanalyk, Russia	2	7	6	1	12	6
Tanganyika, Congo and Rhodesia	6	10	0	4	5	0
LEAD-ZINC:						
BROKEN HILL:						
Amalgamated Zinc	1	7	6	1	6	0
British Broken Hill	2	8	9	2	0	0
Broken Hill Proprietary (8s.)	3	5	6	2	4	3
Broken Hill Block 10 (£10)	1	10	0	1	1	3
Broken Hill North	3	0	0	2	8	9
Broken Hill South	13	5	0	2	2	6
Sulphide Corporation (15s.)	1	6	6	1	2	0
Zinc Corporation (10s.)	1	8	0		19	3
ASIA:						
Burma Corporation	4	10	0	13	7	6
Irtysh Corporation	2	0	0	1	12	6
Russian Mining	1	0	0		18	9
Russo-Asiatic	4	17	6	4	8	9
TIN:						
Aramayo Francke, Bolivia	3	7	6	3	17	6
Bisichi, Nigeria		14	9		15	3
Briseis, Tasmania		5	0		4	6
Dolcoath, Cornwall		10	6		8	6
East Pool, Cornwall	1	9	6		17	9
Ex-Lands Nigeria (2s.), Nigeria		2	9		3	6
Geevor (10s.) Cornwall	1	5	0	1	5	0
Gopeng, Malay	1	16	3	1	18	9
Ipoh Dredging, Malay		15	0	1	0	0
Kamunting, Malaya	1	12	6	2	6	3
Kinta, Malaya	2	10	0	2	12	6
Malayan Tin Dredging, Malay	2	2	6	2	1	3
Mongu (10s.), Nigeria		16	0	1	4	0
Naraguta, Nigeria		17	6		16	6
N. N. Bauchi, Nigeria (10s.)		7	0		8	0
Pahang Consolidated (5s.), Malay.		15	0		15	9
Rayfield, Nigeria		14	6		14	9
Renong Dredging, Siam	2	5	0	2	13	9
Ropp (4s.), Nigeria	1	1	3	1	4	0
Siamese Tin, Siam	3	6	3	3	2	6
South Crofty (5s.), Cornwall	2	0	0	1	1	3
Tebidy Minerals (15s. pd.) Cornw'l		—		1	8	9
Tekka, Malay	4	0	0	4	5	0
Tekka-Taiping, Malay	3	17	6	6	7	6
Tronoh, Malay	2	3	9	2	8	9

* Share capital expanded.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

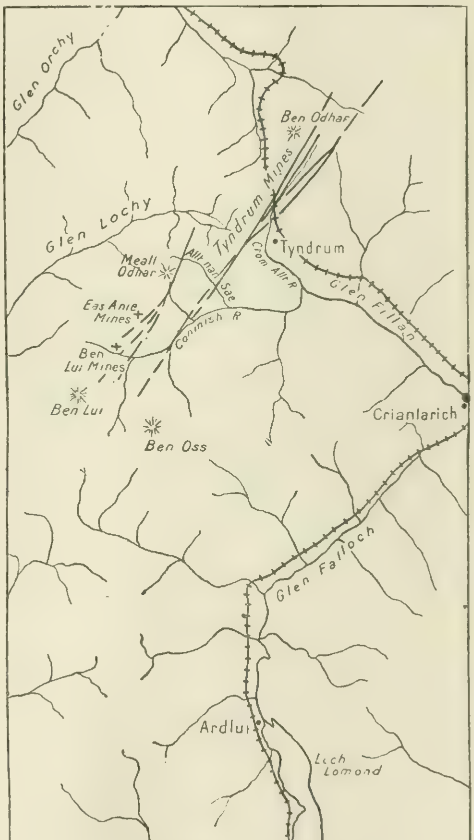
In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

SCOTTISH LEAD AND ZINC MINES.

The Summary of Progress of the Geological Survey of Great Britain for 1918, published last month, contains an outline of the work done in opening lead and zinc deposits. This account has been written by Mr. G. V. Wilson, who made a personal examination of all the workings. We omit the reference to the Wanlockhead and Leadhills mines, as a full description of these appeared in our July issue. The account of the Tyndrum deposits is of particular interest, as the Kinta Tin Mines, Ltd., is working this property, as mentioned in our October issue. Mr. Wilson's report was written some time ago, and much work has been done since.

The veins in the Tyndrum district were accidentally discovered in 1741 by Sir Robert Clifton, who at that time held the mining lease of the Breadalbane property. He opened up the mine, and raised 1,697 tons of lead ore between 1741 and 1745. From that time to 1768 the mine passed through various hands, and in all about 3,318 tons of ore were raised. In 1768 the Scots Mining Co. obtained a lease, erected a smelter about 1 mile east of the mine, and between 1768 and 1790 produced 1,678 tons of lead from 3,683 tons of ore. After 1790 work was only carried on intermittently until 1858, when the Earl of Breadalbane took the mines into his own hands. From 50 to 100 tons of ore were raised annually until his death in 1862, when work ceased. In 1917 the mines were taken over by the Tyndrum Mines, Ltd. This district is situated in an area of metamorphic rocks, consisting mainly of mica schists, quartzites, and quartzose flags, with occasional interbedded schistose bands. A large N.E. fault, throwing down to the S.E., crosses the area.

The metalliferous veins are situated along this fault, and also parallel to it in the area of quartzose rocks occurring on the N.W. Two veins were worked, the Hard Vein (west) and the Clay Vein (east), the latter being a metalliferous portion of the main fault. The ground between is not disturbed to any extent. Farther to the S.W. the veins become known as the Tyndrum Main Vein, and where they cross the Allt-nan-Sae they are about 100 yards apart, the rock between them being much shattered and strung with thin quartz veins. The vein on the north boundary of this shatter zone contains a little iron pyrites only, but that to the south contains also galena and blende. About a quarter of a mile farther south an old level, driven in a N.W. direction, appears to have cut the southern limb of the vein, which, judged by the material in the dump, contained a fair quantity of complex lead-zinc ore. Farther south again, where it crosses the Coninish River, the vein has recently been opened and is found to contain a fair quantity of galena. When traced north from Tyndrum the veins are not seen until they cross the Crom Allt about 1 mile from Tyndrum. Here the Clay Vein has been worked by open-cut a short distance on the N.E. side of the burn, near the road. About a quarter of a mile farther up the burn, however, the fault (Clay Vein) can be seen to contain no ore. Two small offshoots, both of which are metalliferous, cross the burn from the west side, and are cut off against the fault. About 200 yards southward they apparently join, and the conjoint vein is well seen crossing the burn about 100 yards upstream from the railway bridge. The southward extension is nowhere visible, but it probably joins with the Clay Vein near the point where that vein is metalliferous, at the small open-cut already mentioned. The Hard Vein can be traced from Tyndrum to near the top of Beinn Odhar, where it was at one time worked by open-cut and by adit. A little galena and blende can still be found on the dumps. An old shaft and a level about a quarter of a mile west of the Crom Allt railway bridge are also probably on the course of the Hard Vein. About half way between the two main veins, another vein can be traced by trials, and an old adit from the roadside near the railway bridge to a point about ½ mile away up the side of the Beinn Odhar. It is about 4 ft. wide and contains a fair quantity of blende and galena.



LEAD-ZINC ORE DEPOSITS AT TYNDRUM.

The Ben Lui and Coninish mines are to the south-west of Tyndrum. A barren quartz-reef, known as the Mother Reef, runs in a N.E. direction from the Eas Anie to Meall Odhar. About ⅓ mile N.E. of Eas Anie it appears to branch, and from this point southward becomes metalliferous. The westerly branch or branches have been worked at Eas Anie and at Ben Lui. At the former place the adits on the more westerly branch are open, and galena and blende associated with barytes can be seen. At Ben Lui the same minerals occur on the dumps at the mouth of the adit. The easterly branch, which keeps the same trend as the Mother Reef, is visible at a trial on the hill-side about a quarter of a mile S.E. from Eas Anie, and there shows a fair quantity of blende and galena. The veins contain a complex ore scattered through a quartz gangue. The galena and blende are usually, however, in small pieces and intimately mixed, so that it has been impossible to separate them, but with improved plant this may be done. The old dumps at the Tyndrum Mines are estimated to contain about 40,000 tons of material yielding approximately 9·5% of lead and 6·5% of zinc.

The Strontian and Lurga mines are situated in Morvern, a district of Argyll, and are 20 miles south-west of Ben Nevis. They are believed to have been discovered by Sir Alexander Murray, of Stanhope, in the early part of the 18th century. He was the proprietor of Strontian and appears to have leased the mines to the Duke of Norfolk, who afterward made them over to the York Buildings Co. The Lurga mines were leased from the proprietor, the Duke of Argyll, and in a statement made by Duncan Forbes, of Culloden, to the Duke of Argyll, in 1737, we find that the rent paid was £41. 17s. 7½d. In 1733 an interesting map and account of the area was published under the title, "A Plan of Loch Sunart." The Strontian mines were worked continuously until 1815, but since that time the workings have been intermittent and on no great scale. In 1809 the output seems to have been about 400 tons of lead per annum, but it gradually fell away, and when work ceased in 1871 it was only 9 tons. The country rock varies from hard mica schist, with banded quartzites in the west near Coire an-t-suidhe, to augen gneiss at Fee Donald in the east. The veins, several of which have been worked, all have a trend of about 5°N. of W., and except at Coire-an-t-suidhe are associated in each case with a highly decomposed basalt dyke. The primary ores are galena, jamesonite, and zinc blende, with a little pyrites. Galena has been worked extensively at Strontian, at the Whitesmith and Bellsgrove mines. At Coire-an-t-suidhe 30 tons of blende also were extracted in 1871. The gangue consists mainly of barytes and calcite, occasionally with small quantities of strontium minerals such as strontianite and celestine. The Lurga vein is situated in Glen Dubh on the estate of Laudale and about 3 miles south of Laudale House, on the south side of Loch Sunart. It is of the same type as the Strontian veins, and like them is accompanied by a decomposed basalt dyke. The ores are mainly galena and blende, associated with white barytes and quartz, and at one part the vein shows about 4 ft. of fairly clean barytes. The Strontian veins have been worked to a depth of over 100 fm., but the workings are now full of water to adit level. The Coire-an-t-suidhe vein, which is visible at several places, contains a fair quantity of galena, perhaps 10 cwt. per fathom, together with blende up to 1 ft or 18 in. thick still remaining on the foot-wall of some of the open-cut workings.

A large number of mineral veins carrying lead, zinc, and copper ores occur around the Cairnsmore granite mass near Newton Stewart, Wigtown. Blackcraig vein was accidentally discovered in 1763 during the making of the military road, and, soon after, the mine was opened up and the ore was shipped to Chester for smelting. During a recent visit, it was found that at Wood of Cree, now being opened up and worked, an interesting view of the vein can be obtained. The walls are ill defined, and the country rock for a few yards on either side is impregnated and strung with thin veinlets of ore. In addition there occurs near the centre of the vein a definite brecciated zone containing strings of galena and blende ranging up to 4 in. in thickness. Many of the veins of the district are of this composite type, and at Blackcraig the "bearing ground," as the impregnated country-rock is called, attains in places a width of about 20 yards.

PROSPECTING IN WEST AUSTRALIA.

At the meeting of the Institution of Mining and Metallurgy held on October 16, Mr. C. M. Harris read a paper on prospecting in West Australia. We quote the parts of the paper describing the new method known as "loaming" for discovering covered outcrops and detailing the work done by the West Australian Department of Mines in instituting prospecting parties.

Prospecting in West Australia may be said to have started with the discovery of gold at Kimberley in 1883. The results there were not satisfactory, and only a few parties remained, who, working their way south, found gold on the Gascoyne, Ashburton, and Murchison rivers. The discovery of gold near York in 1887 rekindled interest in prospecting, and the finding of this in profitable quantities at Southern Cross enticed a number of men from the Eastern States. It was, however, the discovery of rich ore and alluvial gold by Bayley in 1892, at Coolgardie, that drew the attention of men from all parts of the world to West Australia. With the advent of great numbers of prospectors, new finds were rapidly made, and within five years nearly the whole of the goldfields were discovered.

The early prospectors simply ran over the country as if they were looking for pastoral areas, riding from outcrop to outcrop, and when one of these appeared "likely" a few pieces of lode material were knapped. If any coarse gold were visible a search was made for nuggets and specimens which could be broken down with a hammer and the gold collected. Then came the man who, having less means of transportation, was unable to cover so much ground, but did so more thoroughly. When he found an outcrop he knapped off pieces and crushed them; if any water were available he would pan off his sample, and on coarse gold being found, a shaft would be started, probably on either a quartz or "mullocky" leader. More frequently he would prospect for the alluvial or detrital gold shed from the leader. If there were a scarcity of water, the prospector would use two dishes, about 15 in. in diameter; he would fill one with the broken material, and from about the level of his head would "pour the dirt" into the other dish placed on the ground.

Then he would pick up the second dish and repeat the process. Each operation would cause dust to be blown away, leaving the coarse material and gold, which latter could subsequently be collected. This procedure is called "dry blowing," and men may still be seen carrying on this dusty and dry method of panning, looking for coarse vein gold and small nuggets. If a large quantity of material has to be treated, a shaker is built, consisting of a shallow inclined box about 30 by 20 in., standing on four thin spring legs fitted into sill pieces. The box is fitted with removable trays containing riffle bars, over which is a screen, made out of a piece of tin with holes punched in it, practically a miniature trommel. This is surmounted by a hopper, into which the material is fed. The operator stands on the windward side and rocks it to and from himself. The large pieces run off over the screen, while the finer have to pass over the riffles, the gold gravitating to the bottom. The tray is periodically removed, and the contents are placed in a dish, and either dry blown or panned off. Various improvements to the shaker have been introduced, mainly the addition of bellows by which the tailing is more rapidly worked down the riffles.

By 1897, following the discovery of gold at Kanowna, the old-time prospector had become the alluvial miner, and as it became more difficult to discover new lodes, a new type of prospector was developed. This man with his horse and cart, and a 50 gallon tank to hold water, sets out to examine a belt of country which he considers should be auriferous, preferably near the contact of the granite and greenstone. Then he looks for porphyry dykes and jasper bars, knowing by experience that most of the lodes occur near one of these.

Should the jasper be found in contact with the lode the latter may contain patches of rich ore, but when the lode is in greenstone schist and the jasper bar some distance away there is more chance of the ore shoot being of greater extent. If floaters of quartz or ironstone be found, they are dollied and the sample panned off. Should any "colours of gold" be obtained, he will try and see where these floaters have come from. To do this thoroughly he starts to "loam" the piece of ground he has chosen, taking his loam bag, 6 ft. long and 6 in. diam., made of unbleached calico, with tapes sown to it every 9 in. from top to bottom.

If the ground be on a rise, he starts on the fall or where he found the floaters or indications, makes a hole 4 to 6 in. deep, takes a sample from top to bottom and puts it in his loam bag. He then holds the bag perpendicularly and shakes it well so that all the fine material falls to the bottom, then No. 1 tape is tied. He next proceeds for about 4 yd. across the country and repeats the operation until he has 8 samples, and 8 holes in a row.

Having marked the spot he proceeds to pan off the samples, carefully noting and driving a long stick into the ground in each hole in which the tail (if any) of gold was obtained. If he be lucky enough to secure any colours of gold, he takes another parallel course 10 yd. ahead, starting in front of the first sample which showed the "tail" and proceeding at shorter distances than in the first line, until opposite the samples last taken in the first line, which showed a tail (see the diagram in the next column).

When this second row of samples have been panned off, they will determine whether gold continues further; if it does, or has a tendency to spread out, then a wider line must be taken ahead again, and so on until the loam gold cuts out. The prospector then starts to costean (trench), still proceeding up-hill, and the debris should be panned right along to determine (should no lode or vein be visible) if the gold is going down in the cement or the subsoil. If this be so, the prospector knows he can go on sinking, as sometimes he may have to do for several feet below the surface, often without the slightest sign of the lode until it is cut.

If the prospector be fortunate enough to strike a long shoot of gold, the loams containing a "tail" may be widely spread. On the contrary, the usual characteristic is that the "tail" in the loams will gradually narrow until they cut out, as per sketch. In cases where there is no water available the total contents of each hole are put through a dry-blower, which will, by careful handling, save the finest concentrate, and by the use of a magnifying glass any "tail" of gold can readily be seen. There are several minerals which may be concentrated and make the tail appear to be much richer than it really is. They are cerussite, pyromorphite, crocoite, bismutite, scheelite, and pyrites. The prospector generally roasts his concentrate on a shovel, in a case like this, to "clean the gold."

There are, of course, many details which an intelligent prospector must fill in by his experience. If he works on the above system in places which give prospects sufficiently encouraging to go on, he will find it much quicker and, consequently, much cheaper, than using the older method of costeaning for hundreds of

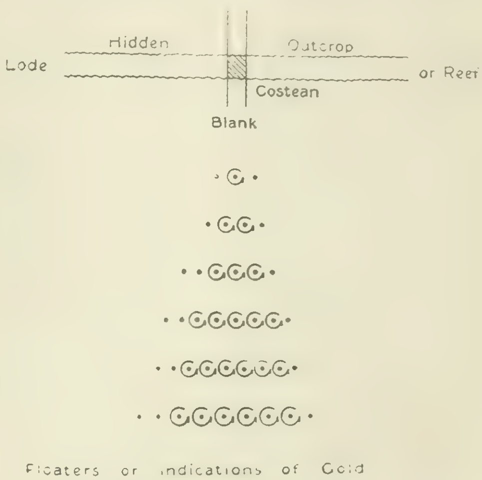


Diagram explaining "Loaming" Method of Prospecting.

feet employed previously when prospecting for hidden outcrops. A number of the more recent discoveries of mines, both in Victoria and in Western Australia, have been made by this method.

The question is how new mines are to be found to replace those which are shut down, or which are rapidly reducing their reserves of ore, owing to high costs caused by the war. This question is being asked the world over, and already attempts have been made to answer it in a practical way. In the history of prospecting it will have been seen that the discovery of the greatest number of goldfields in West Australia took place between 1887 and 1899, and that during the last twenty years few mines have been found.

Some more scientific manner of prospecting must be carried out if we are to make any success of this endeavour. The more easily found outcrops have been discovered and tested, but there must be many others that are hidden, and base metal ores that remain unrecognized. One instance may be quoted, showing how prospectors may easily pass by or turn down a proposition as valueless, whereas another, with a little knowledge, makes a fortune. The case was that of the Silver King mine in Victoria. During the past fifty years the iron-capped lodes at this spot were known to prospectors, but as they only gave a small prospect of gold in the dish, they were considered unpayable. About six years ago, one prospector, who had learned how to utilize the services of the staff of the Mines Department, sent down a sample from one of the lodes for assay. The result was 5 dwt. of gold and 180 oz. of silver per ton. Other instances will be known, not only in Australia, of how good lodes have been unrecognized for years.

This brings us to the education of the prospector. Some 30 years ago, on the Thames goldfield, New Zealand, a number of prospectors clubbed together and formed miniature Schools of Mines. Instructors visited them periodically from the Thames School of Mines and taught them elementary mineralogy and geology. This is the only instance known to the writer of where any attempt was made to train the prospector. The prospector has neither the time nor as a rule the inclination for an extended course of study; the information must be given in tabloid peptonized form.

It was this idea that prompted the calling of a conference of mining men in West Australia last year, when we were faced with the problem of how to find employment for the miners who returned from the front, unable to take up their pre-war avocations. These men were nearly all suffering from gassing, in addition to wounds in the legs and arms, so that it became necessary to find some work which they could do, at the same time building up their health. It was agreed that a scheme should be devised for them to form prospecting parties, but before doing so, they were to be given a short series of lessons in the testing of economic minerals, and in sampling ore; the idea being to teach them how to discriminate between minerals that would pay them to mine, such as scheelite, wolfram, bismuth, tin, copper, lead, graphite, molybdenite, and the other heavy minerals, such as hematite, magnetite, pyrrhotite, pyrolusite, tantalite, barite, and many others that are so frequently mistaken for heavy minerals of value. By means of a small collection of typical minerals, with which each party is supplied, they are enabled to compare any they may find, and know how to make a confirmatory test. Thus, if they find any mineral which they consider likely to be of value, they can test it at once, and if it prove to be so, they send a sample of it down to the Government Mineralogist to be determined and assayed, and go on developing the deposit. If, on the other hand, the mineral proves not to be of an economic type, they need waste no further time on it. They are further instructed in the method of taking a sample of the ore to send down for assay.

A small sub-committee, consisting of Dr. Edward S. Simpson (Perth), the Government Mineralogist and Assayer, and the author offered to take charge of this instruction, and during the last twelve months nearly a hundred returned soldiers have received and appreciated this short course. Naturally, wherever possible, we have extended it by giving lessons on the reading of geological maps, and encouraging the prospectors to look upon the mining geologist and assayer as friends willing and anxious to help them. Thus men have started out with greater knowledge and better equipped in every way than any parties of prospectors before. The State Mines Department has supplied horses and carts or camels, tents, tools, explosives, etc., while the Repatriation Department provides the food for the expedition for six months, and sustenance for the man's family.

Naturally there are weaknesses in the scheme, the principal defect being the want of direct supervision. The Minister then controlling the scheme considered that the prospectors should be allowed to wander about where they chose. The result has been that some parties have stopped round the mining centres, and have done little actual prospecting. The majority have tried old abandoned ground that they had a fancy for, while a few have gone out into new country and are doing good work.

An alteration has been effected in the scheme, the parties being now under the supervision of local committees, consisting of mining men, which is an improvement in that "wasters," and there are always men of this type, are the sooner weeded out.

But even this does not go far enough; the whole system of prospecting must be revised before any great measure of success can be counted on. Instead of a short course of training for all the prospectors, a few should be picked out who have the brains and education to assimilate the necessary knowledge and are capable of leadership. They should be given an intensive course of study in simple mining geology extending over at least six months. Better still, young men, who have been trained at a school of mines and have a practical knowledge of mining, should be given special instruction in this work. They must learn how to read geological maps, to understand the bulletins supplied by the members of the Geological Survey, and to transform them into language understood by the ordinary prospector. Such a man would be put in charge of a party of returned miners, who would be paid wages to do what he tells them.

A special block of country could be mapped out, the fullest data available collected from plans and bulletins, and that block thoroughly and systematically prospected. The results obtained should be recorded in the Mines Department for use at any future date. The latter would on their side reserve that ground from leasing to anyone else while the party was working on it for the discovery of any gold or base metal lodes, the party to be allowed so much time to prospect the block and then be granted a certain acreage of leasehold. This is to eliminate what is termed the "dingo prospector," who never does any prospecting himself, but waits until a find is made, and then pegs out the whole country, and sells his pegs, for that is all he has to dispose of.

The financing of such a scheme is one that needs much more consideration than can be given in this brief paper. Several suggestions have been made, and can be classed under five heads.

(1) Parties subsidized by the Government. This is the present method; the prospectors retain anything they may find, and are only liable to return the subsidy if they are successful. The weakest point in this scheme is the want of leadership and co operation in the party. No definite line of work is carried out.

(2) Prospecting syndicates, in which the "backers" or those who finance the scheme hold shares in varying proportion, as do the prospectors. If the party is under a good leader, satisfactory results may be obtained, but as a rule syndicates are unwilling to pay a sufficient salary to tempt a really good man to take charge.

(3) Parties employed by the Government under a mining geologist to carry out detailed examination of separate areas, including a care ul search for mineral deposits or indications, and the selection of the most promising areas on which prospectors could take up ground. They would be assisted by the Government to the extent of half the cost of wages and stores. This method is to be started in New South Wales, and is a step in the right direction.

(4) Prospecting parties sent out by mining companies employing returned soldiers on wages under a mining geologist. As leader, he would have the power of dismissal of any of the party, and any rewards should

be in the shape of a bonus to be paid on the discovery of any ground worth taking up. It has been found by experience that a direct monetary reward in addition to wages is better than being given a share interest. This is especially so in the case of a company which is looking out for a new property to take the place of the old mine. The prospector on his part, with the money received, is then able to go out on his own account, if he wishes to do so.

(5) The suggestion coming from Mr. Mortimer Lamb, in Canada, of forming a national prospecting company, under a board of management, composed of mining engineers of repute, in whom the subscribing public have confidence, is one that opens up very great possibilities. Tens of thousands of pounds are lost annually by the public all over the world in prospecting syndicates, and in small gold-mining companies, because they are badly handled. Whereas, with such a company, the shareholders would be sure of having the best advice possible, the management would be above reproach, and high-class leaders could be secured.

COAL IN FRENCH INDO-CHINA.

The *Far Eastern Review* (Shanghai) for September contains an account of coal deposits in Tonkin, the northernmost province of French Indo-China, translated from the Bulletin of the Comité d'Assistance aux Travailleurs Indo-Chinois. We make the following brief extracts from this account.

Tonkin is the only one of the five divisions of French Indo-China in which the mines have reached the working stage. The coal mines, worked since 1888, have doubled their output during the last 10 years, while as for the metal mines their production, which was practically nil in 1905, reached in 1916 totals of 49,000 tons of zinc ore and 932 tons of tin and tungsten ores. Tonkin possesses extensive strata of hard coal. These strata belong to the same geologic formation, Rhaetic. The coal formation stretches for 180 kilometres from Mon-cay, in the east, to Seven Pagodas in the west, with an average width of five kilometres. At Ha-long the coal has the following average composition: Volatile matter 8 to 11%, ash 2·5 to 7%, fixed carbon 85 to 88%, sulphur less than 1%, calorific units 7,800 to 8,400. This coal closely approaches in quality the best hard coal from South Wales. It is an excellent fuel, burning without smoke and giving no clinker. It burns equally well when mixed half and half with bituminous coals, and more than 100,000 tons is sent annually to Japan and China for this purpose. The known reserves are very considerable and are geographically situated in exceptionally favourable spots, either on the coast, by sheltered roadsteads accessible to vessels of 4,000 to 6,000 tons (as Hongay, Kebao, and the mines of Port Courbet) or (as the mines in the region of Dong-trien) at small distances from waterways navigable by lighters of 100 tons which in a few hours can be towed to Haiphong. Markets are now widely open for the coal, both in Indo-China, whose well-planned industrial development will not long delay in realizing its full scope, and in the neighbouring countries, China, Japan, Hongkong, Singapore, and even Vladivostok, and, perhaps later, on the west coast of North America where anthracite is in demand.

The article proceeds to describe the principal collieries.

The first operators of coal deposits at Ha-long Bay were the Chinese, who, about the year 1865, opened several workings to furnish the warships of the Chinese Government with the necessary fuel. It was not long before these deposits attracted the attention of the first explorers of Tonkin, and from 1881 a mission was entrusted to Fuchs, then Engineer-in-Chief of Mines, and to Saladin, Civil Engineer of Mines, to study the coal region about Ha-long and Pha-si-long Bays. The account of the work of this mission appeared in the "Annales des Mines" in 1882, and the conclusions then arrived at were very favourable. Following Fuchs' travels, and in conformity with his proposals, the Government decided to send a new mission which was entrusted to the leadership of Sarran, Colonial Engineer of Mines, and which extended from 1885 to 1886. In 1888 Sarran published, under the title of "Etude sur le Bassin Houiller du Tonkin," a work which is still to this day the most complete study which has been published on the hard coal mines of Tonkin. Then since 1884, M. Bavier Chauffour, representing a group of French capitalists whose attention had been drawn to the deposits of Ha-long Bay by Fuchs' mission, had obtained from the Annam Government, for a payment of $100,000, the concession of these deposits. The French Government contested the validity of this contract, but after a long discussion accepted a settlement of the dispute and in 1887 conceded to M. Bavier Chauffour the mines of Hongay. The proprietary company is now called the "Société Francaise des Charbonnages du Tonkin." The early days of the company were attended with difficulty. From 1888 to 1900 it just managed to exist, struggling against obstacles of all kinds. At last in 1900, thanks to its tenacity and energy, these difficulties were overcome, and from that time complete success crowned its efforts. The Société produced 600,000 tons of coal in 1916, and its shares issued at 500 fr. are to-day worth more than 2,500 fr.

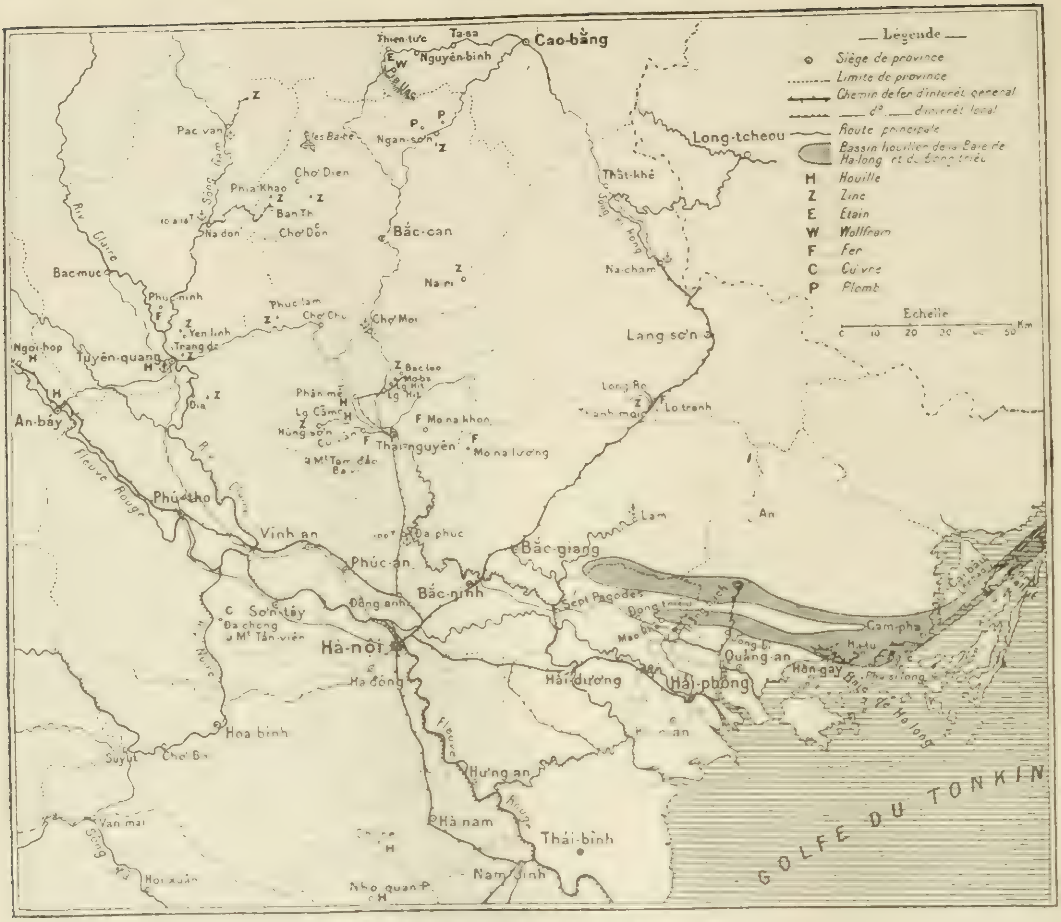
The coal seams known within the limits of the Hongay concession have been classed in two systems: the Hatu and Nagotna. To the first system belongs the following seams:

(1) The upper seam of 0·5 metres to 0·8 metres thick considered unworkable to-day.
(2) The main seam of which the thickness varies from 50 to 60 metres with a workable thickness of 30 metres of good coal. This seam is worked at Hatu and Cam-pha.
(3) The flooded seam 50 or 60 metres below the preceding seam, with a thickness of 2·5 metres and which is not actually being worked.
(4) The seam 180 metres below the main seam found only in Hill 158. Its useful thickness is 13 metres. It is being worked at Hatu at the foot of Hill 158.

The Nagotna system comprises a dozen known seams having a workable thickness of from one to eight metres. Four of these, at Nagotna, are worked underground by shafts and galleries. It would appear that the seams worked at Nga-hai recently, and at Mong Duong since 1908, belong to this system.

The greater part of the tonnage extracted comes from the main seam worked by open-cut at Hatu, which in 1916 supplied 280,000 tons of coal from the three open workings of N.S., Monplanet, and Hill 158, and at Cam-pha where 170,000 tons were obtained in the same year. In all these open cuts the coal is cut into benches, each bench being from 5 to 6 metres high. The slope is maintained at an angle of 45° in order to prevent landslides.

Underground workings into the hill-sides are carried on at Hatu in the 16 metre seam at Mong-Duong in



MAP OF THE TONKIN COAL DISTRICT.

which there are 8 metres of workable coal, and at Nga-Hai in the two seams of which there is an average thickness of 2 metres available. At Hatu and Mong-Duong the horizontal gallery is used ; at Nga-Hai inclined galleries. Altogether these underground workings produce 120,000 tons of coal annually.

In order to meet the demands of steamship and railway companies the Société des Charbonnages has established an important works at Hongay for the manufacture of briquettes composed of about 30% of bituminous Japanese coal and 70% of hard small local coal. The binding material is coal tar which came from Europe or America before the war and of which a certain quantity is now supplied by Japan. The annual production is 130,000 to 140,000 tons. A battery of nine Coppée furnaces produces 25 to 30 tons of coke per day, thus meeting the needs of the Société and the various construction shops in Indo-China. The coal treated for coke is a mixture of bituminous Japanese and hard Hongay coal.

Another mine is at Kebao. This was conceded in 1888 to Jean Dupuis as a recompense for his services to the French cause in the Far East. The coal is bituminous, and of high grade, but the seams are too narrow for underground mining. The first operating company failed after having spent in about 10 years more than 10,000,000 fr. Since 1901 the output has been about 12,000 tons of coal per year.

There are also mines at Dong-trieu. The region of Dong-trieu forms the western extremity of the band of Rhætian beds to which belong the deposits of Kebao and Hongay. It stretches for a length of 20 kilometres from east to west, between Uong-Bi on the east and Maokhe to the west. The southern series contains about 20 seams of from one to 10 metres thickness, giving a coal of good quality of the same character as that from the bay of Ha long, but generally containing less volatile matter and more ash. The Edouard and Schoedelin workings employ about 700 workpeople, and for about 12 years have supplied about 30,000 to 40,000 tons per year on the average. The deposits on the northern series, which have recently been discovered, contain coal which is a real anthracite containing only 1% of volatile matter. The examinations show a system of at least ten seams, of which the workable thickness varies from two to ten metres, coming to the surface for a distance of 20 to 25 kilometres.

Between Hongay and Dong-Trieu the Rhætian strata contain many deposits of coal which are worked by small concessions. The Francis, Hien, Marcelle, Paul, and Renee concessions together turned out in 1916, 33,000 tons of coal.

The discovery of deposits of bituminous coal in Tonkin is quite recent and has excited great interest, for the colony is at present dependent upon Japan for this class of fuel. The mines of Phan-Me are situated at about 15 kilometres to the north-west of Thai-Nguyen in close proximity to the Song-Cau river and the road from Thai-Nguyen to Bac-Can. Their geographical situation is scarcely favourable, for the Song-Cau at this point is not navigable to any boats but the smallest (four to five tons at the most). But the construction of a railway from Thai-Nguyen to Dong-Anh has been discussed lately. This would enable the coal to be discharged easily and cheaply on the delta. The coal of Phan-Me contains 25% of volatile matter, 1 to 2% of sulphur, and 5 to 10% of ash. Its calorific power is 7,650; it makes an excellent metallurgical coke, light, and not breaking easily. Preliminary workings have proved seven seams of coal of a working thickness varying from 1·5 metres to 5 metres. Five kilometres from this point to Lang-Cam in a hill about 200 metres high there has recently been found a series of seams, about ten, of one of which the workable thickness is about 10 metres. This is supposed to be a continuation of the seams at Phan-Me. Particular importance is attached to the deposits at Phan-Me from the fact of its proximity to extensive deposits of iron ore which is very rich and pure. The creation of a large metallurgical enterprise is being planned for the treatment at Thai-Nguyen of the iron ore of the region with coke from Phan-Me.

The Phu-Nho-Quan mines are situated about 7 kilometres from Ninh Binh, which is about 150 kilometres from Haiphong and accessible to ships of large tonnage. The coal contains on the average about 18% of volatile matter, and is more sulphurous than the coal of Phan-Me. It is capable of supplying a good combustible, particularly when it is mixed with the hard coals of Tonkin which have, as has already been said, a small content of sulphur. A great number of outcrops have been found and the few workings which have been put in hand show vertical seams.

Finally, mention should be made of the existence at Tonkin of numerous deposits of Tertiary coal, notably along the valley of the Red River, at Coa Bang, Dong-Giao, and Tuyen-Quang. The coal makes a good fuel. That at Dong Giao, the deposits of which have to day been abandoned, yielded from one layer of 9 metres thickness about 100,000 tons, which was nearly all consumed by the railways of the protectorate. Similarly the railways are the principal clients of the mine at Tuyen-Quang, opened for exploitation in 1915, where a seam of an average working thickness of 8 metres is being exploited and is supplying a good engine coal of which the average analysis is as follows: Volatile matter 35 to 40%, fixed carbon 45 to 50%, sulphur 1·5 to 2%, ash 1 to 12%. The workings were at first open-cut, but are now underground. The production of this mine in 1916 was 12,000 tons and was expected to reach 15,000 tons in 1917, with a probable continued expansion.

ELECTROSTATIC PRECIPITATION OF SILVER-REFINERY FUME.

Chemical and Metallurgical Engineering for September 15 contains an article by W. G. Smith and A. A. Heimrod describing the plant at the silver refinery of the United States Metal Refining Co., at Chrome, New Jersey, used for precipitating fume by the Cottrell electrostatic process.

The plant is installed at the end of a long flue system, in the course of which is a large settling chamber, and spraying and scrubbing apparatus. It consists of a steel frame supporting top and bottom headers of lead, connected by means of lead precipitator pipes. Three units are provided, each of which is suitable for handling approximately 4,000 cu. ft. of gas per minute at 115° to 150°F. at a velocity of 7 ft. per second through the pipes, or in case of necessity 8,000 cu. ft. per minute at a velocity of 14 ft. per second through the pipes, with only a very slight decrease in efficiency. Each precipitator unit is 8 ft. 8 in. by 8 ft. measured from the inside of the precipitator-column supports, and has an overall height from foundation to the peak of the open top header of 34 feet. All of the parts of the precipitator that come directly in contact with the gases are made entirely of the best electrolytic lead, free from antimony. It has been found that the gases containing selenious and selenic acid destroy lead which contains as low as 0·1% antimony, so no lead containing antimony was used in the construction. Any steel work that might be subjected to exposure to the gases was covered with lead in such a way that no fume could come in direct contact with the iron. The fumes and gases from the silver-refinery furnaces are conducted into the bottom header through an inlet at each side of each unit, close to the top of the bottom header chamber. Each of these inlets is provided with a liquid-seal gas-tight jug damper in order to permit the shutting off of any unit and clearing it entirely of gas without interfering with the operation of the remaining units, thereby giving to the whole installation flexibility and assuring continuous operation. These jug dampers are on and supported by the top of the 2 ft. by 3 ft. rectangular bustle pipe extending along each side of the precipitator units. This bustle pipe is in turn supported by hanger rods from the main structure. The bottom header chamber is made of 8 lb. lead, the end walls being supported by lead clips fastened to the structural steel frame. In the bottom of the header box a 6 in. diameter lead drain pipe is provided in order to facilitate the flushing out of the collected precipitated material into settling tanks alongside the precipitator. Ready accessibility to the bottom header is provided by means of doors, which can be easily opened to inspect the electrode systems.

Each precipitator unit has 30 collecting electrode pipes 16 ft. long. Twenty-six of these pipes have an internal diameter of 8 in., and the four corner pipes have an internal diameter of 11 in. The increased diameter of these corner pipes permits the installation of a stiff electrode to steady the discharge electrode system and prevent it from swinging or swaying due to irregularities of gas flow or in electrical conditions. This avoids the use of insulators in the bottom header and thereby eliminates possibilities of insulator leakage trouble at this point. The precipitator pipes extend into the bottom header for 4 ft. The gas inlets are so arranged that the gas flows in near the top of the bottom header box, circulates around the pipes, flows down to the bottom, then up through the pipes, and discharges into the top header box. This arrangement tends to break up any irregularities in the flow of the incoming gases, equalizes the gas pressure in the bottom header, tends to heat all of the pipes to a uniform temperature, and thus ensures proper distribution of the gases in the various pipes. The gases passing through the electrical field are cleaned, and are discharged at the top of the precipitator into the top header and to the atmosphere. The solid and liquid particles carried by the gas are collected on the inside surfaces of the collecting electrode pipes, from which the precipitate is periodically washed into the bottom header by means of a washing system installed in the top header. This cleaning operation is performed only on idle units, the gas temporarily being diverted to other units and the electric power line switch opened. This can readily be done, as high voltage selector switches have been installed in the electrical house whereby a precipitator unit can be put in or taken out of service without disturbing the operation of the electrical equipment or gas flow to the remaining units.

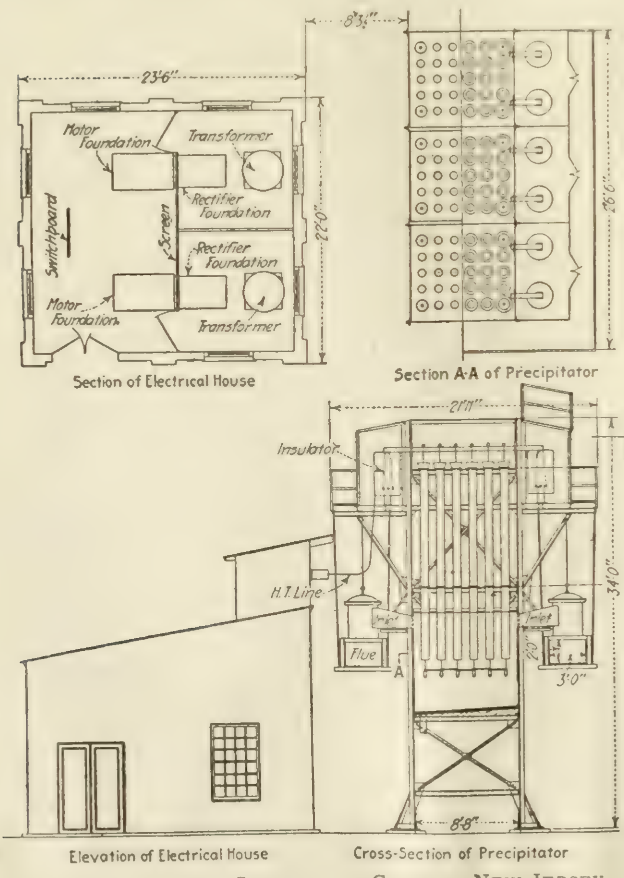
The top header of each precipitator unit is lead-lined throughout and is open to the atmosphere at the top. The end walls of these headers have been provided with two openings to allow the high-tension framework to pass through to the steel insulator compartments, where it is supported on corrugated pillar-type insulators 3 ft. high. These are hooded with steel hoods in order to protect the insulators from moist gas and bad weather conditions.

The installing of the collecting electrode pipes was accomplished by passing a mandrel through the pipes so as to remove any irregularities such as projections or dents. They were then passed through the lead-covered steel top-header supporting plate, which was drilled to allow the pipes to pass through freely to the second steel lead-covered supporting plate 9 ft. 9 in. below the top header. After the pipes were in place they were burned to the sheet-lead covering on the supporting plates and to the top plate of the lower header, thereby making the pipes hang plumb and assuring a tight joint around pipes where they enter the bottom header.

The discharge electrode system of each unit consists of, first, four corrugated pillar-type insulators, two on each side of the precipitator unit, insulating the high tension frame from ground; these insulators, as stated before, are protected against bad atmospheric conditions by means of sheet-iron hoods. Second, the electrodes are made up of a star section lead-covered iron wire, carefully centred in the pipes and supported from 2 in. pipe bus-bars. The corner pipes have stiff electrodes made of 1½ in. lead-covered extra heavy wrought iron pipe. Around that portion of the electrode that is in the precipitator pipe is a spiral of star-section lead-covered iron wire, the same as used in the other pipes. Third, the electrode system is tied together at the bottom by a sway frame to the stiff corner electrodes, and on the end of each electrode, in order to hold it straight in the centre of the pipe, is a 20 lb. lead weight.

The electrical equipment for the transformation of the available power supply at 250 volts direct current to the required potential of 65,000 volts is placed in a building close to the base of the precipitator. The supply lines run through a main line switch and fuses mounted in a steel cabinet on the wall and from this point to the switchboard. This arrangement makes it possible to disconnect entirely the main switchboard buses and all auxiliary wiring from the power-supply lines. The switchboard consists of two slate panels, each having a main and a lower section, and each controlling independently one of the duplicate sets of electrical apparatus. The lower panel sections are reserved for the motor starter face-plate, manual operating handle, overload and under-voltage trip-coils. The main sections of each panel have mounted upon them all the control equipment except the motor starters and high tension switching devices. On each main section is a single-pole circuit-breaker in the motor circuit (protecting that side of the circuit not protected by the overload coil on the motor starter); a main line motor switch; a generator field switch and a field discharge resistance; a generator field rheostat operating handle (with rheostat on the back of the panel); a double pole, overload trip, under-voltage release, circuit-breaker in the line from the generator to the transformer; a rheostat switch; a double-pole double-throw reversing-switch and a transformer tap switch in this same line; and a voltmeter and an ammeter in the transformer circuit. By means of a potential plug the voltage may be measured either at the generator terminals or the transformer terminals, the difference being the voltage drop across the line rheostat, plus a small line drop.

The two motor generator sets consist of a 40 h.p., 220 volt, 150 amp. motor, and a 25 k.v.a., 220 volt, 113 amp. single-phase 60 cycle generator, both manufactured by the Westinghouse Electric & Manufacturing Co., and supplied to generate the alternating current. The mechanical rectifiers, directly connected to and therefore operated in synchronism with the motor generator set, were manufactured and supplied by the Research Corporation. Near the rectifiers are the high voltage transformers rated as follows: 25 k.v.a.,



Cottrell Fume Settler at Chrome, New Jersey.

200 volts low tension, 75,000, 70,000, 65,000, 60,000, 55,000 volts high tension; 60 cycles, complete with oil gauge and choke coils. The arrangement of the apparatus is such that the high-tension equipment of each set is completely screened off from the other set and from the low-tension apparatus.

The path of the electric power is from the generator at 220 volts, single phase, 60 cycles, through the switchboard control equipment and line rheostat to the transformer at the same frequency but at reduced voltage (line rheostat drop). The transformer "steps up" the voltage to about 65,000 volts and furnishes power at this voltage directly to the mechanical rectifier without going through any switching devices. Choke coils in the transformer circuit and resistances in the line afford protection against surges. The rectifier reverses the polarity of one-half of each complete cycle and supplies unidirectional current at about 65,000 volts to its main high-tension bus. One terminal of the rectifier is permanently grounded. Each rectifier is connected directly without switching devices to its individual high-tension bus. The three lines from the precipitator units are brought in through the wall of the building near the roof to three separate switching buses, which are so arranged that by means of a grounded mechanical remote control handle near the motor generator sets any or all of the three precipitator units may be connected to either of the main power buses. These switches can be operated with the buses alive, and the change over from one unit to another can be made in a very short time. It is good practice to reduce the voltage about 25% before undertaking any high-tension switching. The high-tension switches are provided with padlocks so that a mechanic before going to work on a precipitator unit can lock the switch in an open position, take the key with him, and be certain that voltage cannot be applied to the unit upon which he is working, the operator meanwhile being free to manipulate the two other precipitator units without interference.

The precipitator operates as close to 100% clearance as any one can wish for, and this condition is always maintained on account of the high values in the fume recovered. As soon as this precipitator becomes overloaded with the precipitated fume in the precipitator pipes the operator can readily detect this condition by his instruments on the switchboard and by the general operation and appearance of the spark at the rectifier. The high-tension selector switches in the electrical equipment house are then operated, to cut in the spare unit; the jug dampers on the inlets to the units are opened or closed as the case may be to put the unit into service or to take it out. The precipitate is then washed from the pipes by means of the flushing system. This operation varies, due largely to the selenium content of the fume; the higher the percentage of selenium in the precipitated fume the more often it is necessary to take a unit out of operation to clean the collecting and discharge electrodes. The recoveries, judging from the short time the precipitator has been in operation, will be even greater than those indicated by the preliminary single pipe tests based on which appropriations for the construction of the commercial installation were readily made.

The paper contains the following useful bibliography relating to the Cottrell process: Problem in Smoke, Fume, and Dust Abatement, F. G. Cottrell, Smithsonian Reports, 1913. Recent Progress in Electrical Smoke Precipitation, F. G. Cottrell, presented before the Second Pan American Scientific Congress, Washington, Dec. 27, 1915, to Jan. 8, 1916. Cottrell Processes of Electrical Precipitation, Walter A. Schmidt, Trans. Am. Inst. Chem. Eng., vol. 8, 1915. The Cottrell Precipitation Process and Its Application to Foundry Dust Problems, H. D. Egbert, American Foundrymen's Association, Milwaukee, Oct. 7–11, 1918. Treatment of Silver Furnace Fume by the Cottrell Process, C. H. Aldrich, Trans. Am. Electrochem. Soc., Vol. 28, September, 1915.

Gold-Zinc Cyanide.—In the *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa for August, W. R. Feldtmann draws attention to a double cyanide of gold and zinc which has, apparently, not hitherto been recorded. This can be produced in two forms:

(1) When solutions of, respectively, one equivalent of $ZnCl_2$ and two equivalents of $KAuCy_2$ are mixed and allowed to stand for some hours, crystals deposit which, although minute, are easily identified under a low-power microscope as hexagonal prisms. These are nearly colourless, with just a perceptible greenish tinge. They form slowly in dilute solutions; for instance, from a mixed solution carrying $\frac{1}{4}$% of $KAuCy_2$, crystals commenced to separate in half an hour, and continued to deposit for at least two days. Similar crystals are obtained by adding HCl to a cold cyanide solution containing gold and zinc in the proportions above indicated, until the solution is just acid to methyl orange. Except for the resulting presence of free HCy, this amounts to the same thing as adding $ZnCl_2$ solution to $KAuCy_2$ solution. For $KAuCy_2$ is a neutral salt, and it has been found that K_2ZnCy_4, in dilute solution, requires four equivalents of HCl to neutralize it, so that the point at which methyl orange shows commencing acidity is the point at which all free cyanide has been decomposed and the K_2ZnCy_4 has been converted to $ZnCl_2$.

(2) If a solution containing two equivalents $KAuCy_2$ is mixed with two equivalents KCy and then with four equivalents of HCl, heated to boiling point and allowed to cool, and if a solution of one equivalent of $ZnCl_2$ is then added and the mixture allowed to stand for some hours, a slow separation of crystals again takes place. But the compound produced by this method is found to be composed of hexagonal pyramids or pyramidal combinations, in which the prism faces are absent. These crystals, also, are nearly colourless but, in bulk, have a perceptible grey or lavender tinge. The same pyramidal crystals can be formed by adding to the acidified, heated, and re-cooled gold solution containing zinc in the proportion indicated, provided that sufficient HCl is present to render the final mixture just acid to methyl orange. If too little acid has been added, insoluble octahedra separate, but carrying an appreciable amount of gold. If, before the pyramidal crystals have time to form in the mixed solutions described above, the solutions are heated to boiling point, no pyramidal crystals appear, but only hexagonal prisms; that is, the prismatic is apparently the more stable form of the compound.

Gold and zinc were separated and estimated gravimetrically (the cyanogen being arrived at by difference) in both the prismatic and the pyramidal forms of the gold-zinc cyanide. The percentage composition was found to be the same in both cases, namely, 69% gold and 11·4% zinc, corresponding sufficiently closely to the empirical formula Au_2ZnCy_4, with 69·9% gold and 11·6% zinc. In their general chemical characteristics the two forms of the compound have not been found, so far as observed, to differ materially. Nevertheless there is a difference in origin, a difference in crystal habit, and a consistent difference in such slight tinge of colour as the crystals show in bulk. Collectively these points seem to indicate that this is a case of isomerism, and not merely physical isomerism or allotropy, but chemical isomerism, possibly as between Au_2ZnCy_4 and $ZnAu_2Cy_4$, with gold as the base in the prismatic form and zinc as the base in the pyramidal form. The formation of the prismatic isomer may be expressed as:

$$ZnCl_2 + 2(AuCy,KCy) = 2KCl + (AuCy)_2ZnCy_2 \text{ (or } Au_2ZnCy_4).$$

But the formation of the pyramidal isomer cannot be quite analogous, as $ZnCl_2$ is not acted on by HCy; on the contrary, $ZnCy_2$ is decomposed by HCl. The reaction of formation cannot therefore be:

$$ZnCl_2 + 2(AuCy,HCy) = 2HCl + (AuCy)_2ZnCy_2.$$

but may probably be correctly represented as the action of aurocyanhydric acid on $ZnCl_2$, thus:

$$ZnCl_2 + 2HAuCy_2 = 2HCl + ZnAu_2Cy_4.$$

It should be noted that the reaction is an incomplete one, but the exact reason for this has not been ascertained.

In water, cold or hot, both forms of crystals are insoluble. They are slowly soluble in strong solutions of alkaline cyanides. Cold HCl, even if fairly concentrated, only attacks them slowly, with separation of AuCy. They dissolve readily in cold solutions of the alkalis and in ammonia. If, to the alkaline solution so formed, HCl is slowly added, zinc hydrate is precipitated, which on further addition of acid redissolves. When sufficient HCl has been added to render the solution just acid to methyl orange, the zinc-gold compound separates again (slowly, if the solution was diluted considerably), but only in the prismatic form, whether the crystals dissolved were prisms or pyramids; that is, the reaction in this case is once more between $ZnCl_2$ and $KAuCy_2$. Sodium sulphide decomposes both crystals with separation of zinc sulphide and formation of alkaline aurocyanide. The zinc sulphide retains just a trace of gold which can easily be separated by treatment with dilute HCl and filtering, the zinc being reprecipitated in the filtrate. The sodium sulphide method of decomposition was found to be a convenient way of separating the metals for the purpose of analysing the zinc-gold compound. When digested with a strong solution of pota sium or sodium carbonate the crystals are decomposed with formation of zinc carbonate, the gold again going into solution as alkaline aurocyanide.

The crystals can be heated at considerably above the boiling point of water without undergoing any change. When the temperature is gradually increased they first lose cyanogen and become blackened with separated carbon. On further heating they become bright again, with a brassy gold colour, without loss of crystal form. When the temperature approaches red heat a sudden change becomes apparent, a red glow passes through the mass, the colour changes to a bronzy hue, and the crystals are then found to have fritted and lost their form.

Diamond Drilling.—The September *Bulletin* of the American Institute of Mining and Metallurgical Engineers contains a paper by O. Hall and V. P. Row describing the method of keeping diamond-drill holes straight as adopted at the mines of the Mond Nickel Company, Sudbury, Ontario.

The Mond Nickel Co. found on two properties that holes, started vertically, were out as much as 400 ft. at depths of 1,200 to 1,800 ft. Having several holes to go to depths of 2,500 to 3,000 ft., it was necessary to find a method of controlling curvature. After considerable expensive experimentation, the company has adopted a standard practice of wedging that appears to overcome one of the chief limitations of the diamond-drill. Holes that warrant the expense are wedged back to vertical or back to a straight line as soon as they show deflection of over 3°. A diagram of diverting wedges is shown in Fig. 1. Each wedging requires the use of a wooden plug, a drive wedge *A*, a pilot wedge *B*, a deflecting wedge *D*, a special clinometer *C*, and a special reaming bit *E*. Wedging is possible in any hole and no change of size is made, that is, a No. 5 hole remains No. 5 size, a No. 1 hole No. 1 size, and a No. 2 hole No. 2 size. The dimensions and descriptions given are for No. 1 holes.

To wedge a hole at any point, a dry, turned, wooden plug grooved to allow water to pass is pushed down with the rods to the point where it is desired to branch the hole, and allowed to swell. A drive wedge is then dropped into the hole and driven into the wooden plug, using a blank bit for driving. The drive wedge, being cut out below the face, usually falls with the face of the wedge in the direction of the dip, but in every case its position is surveyed carefully by using the special clinometer *C*, Fig. 2. Lines are cut on the inside of the clinometer parallel to and in the plane of the long axis of the 30° bevelled part of the clinometer. Lines indicating this plane are marked on the sides of a glass test-tube with a small carbon, the low point of the bevel face being indicated. The glass tube is filled to a height of about 2 in. with hydrofluoric acid diluted with two parts of water, a cork put in, gummed paper placed over the cork and fastened to the sides of the tube, and the plane marked across the paper so that it fits the clinometer snugly and when lowered into the clinometer the marks coincide. The clinometer is lowered into the hole and allowed to set 30 minutes to take the etching; it is then pulled up, the tube cleaned and dried, and the low and high points of the etching marked when the tube is held vertical. The relative direction of the face of the drive wedge and the dip of the hole are indicated. If the two low points coincide, they are the same, and it is only necessary to set the face of the pilot wedge and the face of the deflecting wedge in the same direction and lower them. If the two low marks do not coincide, it is necessary to determine the angle between them and to rotate the pilot wedge with regard to the deflecting wedge, to bring the deflecting wedge, when in place, in a direction opposite to the dip of the hole. Strips of paper wound around the test-tube and wedges allow marking and measuring the arc determining the angle. If the dip is small, a standard dip protractor or the transit and protractor may be necessary to determine the low point of the etching.

A ring is left at the top of the deflecting wedge to lower it. The pilot wedge and deflecting wedge properly orientated are lowered by riveting a special lowering plug threaded into a blank bit to the ring with a copper rivet. Neither the 30° face of the drive wedge nor the face of the pilot wedge is brought to a thin point, but an end ½ in. thick is left. This provides a surface for driving the drive wedge; also, in one position, the point of the pilot wedge will rest on the point of the drive wedge and on being rotated 180° the pilot wedge will drop 2 in. into its place, indicating when the two are in their proper relation. Shearing of the copper rivet gives a further drop of 3 in. The amount of stretch in the rods must also be taken into account in working at depth; 1,500 ft. of No. 1 rods have about 2.5 in. of slack. When the deflecting wedge is in place, a No. 5 bit and core barrel are used and a No. 5 hole drilled to a point 3 or 4 ft. below the wedge. The curved face of the deflecting wedge is No. 5 size, so the No. 5 bit follows the wedge without cutting into

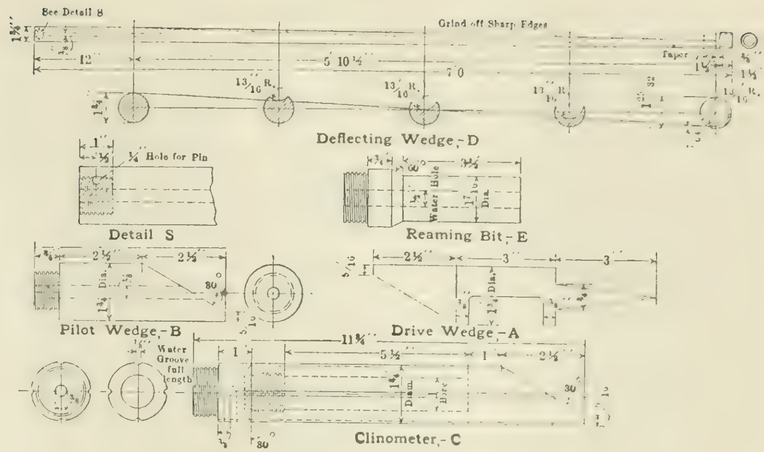


FIG. 2. DETAILS OF WEDGES AND CLINOMETER.

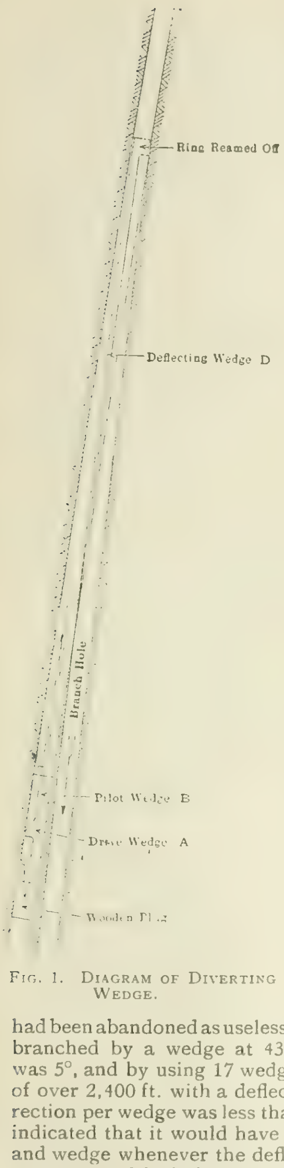


FIG. 1. DIAGRAM OF DIVERTING WEDGE.

it. After the No. 5 drilling, the wedge and deflecting hole are reamed out with the special reaming bit No. 5. The small part of this is No. 5 size and acts as a pilot. Diamonds are set in the bevelled part to ream the wedge and hole out to No. 1 size. After doing this, the regular No. 1 rods and No. 1 bit are used, but reaming with the No. 1 bit is started at the top of the wedge to make sure there is ample clearance for passing up and down. The No. 1 hole is continued as a No. 1 hole below the wedge.

Wedging was first tried in a vertical hole that had been abandoned as useless at 1,100 ft. The hole was branched by a wedge at 436 ft. where the deflection was 5°, and by using 17 wedges, was guided to a depth of over 2,400 ft. with a deflection under 24°. The correction per wedge was less than expected, and the work indicated that it would have paid to start a new hole and wedge whenever the deflection exceeded 3°. The upper part of the hole was in fissured granite or gneiss; the lower, in fissured quartzite. The first wedgings were expensive and only partly satisfactory, but a skilful setter and crew corrected the difficulties, making accurate wedgings without difficulty after the third wedging. The average correction per wedge was 2°. Two subsequent holes in norite, greenstone, and granite were drilled to depths of over 2,500 ft., keeping the deflection within 5° by using three wedges in each. One of these holes had deflected to 5° at a depth of 362 ft. It was wedged at 328, 472, and 580 ft., bringing it back to 1° 10′. The other was out 2° 25′ at a depth of 700 ft. A wedge brought this back to 0° 35′. Though new to the work the setters and crews on the latter holes had no difficulties. Thin core shells lowered to recover lost cores should be lowered slowly past the top of a wedge. The first deflecting wedges were made without the extra foot of the base and one gave trouble by loosening.

This wedging method, in addition to overcoming curvature, can be used to branch a hole for any purpose, for securing additional records of strata or additional samples of the vein or deposit. The application of wedging to the correction of curvature appears to overcome one of the chief limitations of the diamond-drill.

Magnesite in the United States.—The *Mining and Scientific Press* for August 30 contains an article on the magnesite industry of the United States, written by W. C. Phalen, mineral technologist to the Bureau of Mines. The development of the California and Washington deposits was prompted by war conditions, for before that era 96 to 97% of the supply was imported, chiefly from Austria. The home production of 3 to 4% came entirely from California. During 1917, after a fair recovery from the slump which the industry experienced in 1915 as a result of the cessation of imports and before home production had gained much headway, import amounted to only 11% of the total quantity consumed, and of this 11% a portion, which was high in lime, came from Canada. From a pre-war output of about 10,000 tons reckoned as "crude," production in California increased to 211,000 tons in 1917, but fell back to 90,000 tons in 1918. Production in the state of Washington began in December, 1916, with an output of 715 tons, increasing to 105,000 tons in 1917, and approximately 130,000 tons in 1918.

Magnesite is widely distributed in California, occurring in the Coast range and along the west slope of the Sierra Nevada. Deposits are known to extend from Mendocino county on the north to Riverside county on the south, a distance of 500 miles. The Coast range counties in which it is known to occur are Alameda, Mendocino, Mapa, San Benito, Santa Clara, Sonoma, and Stanislaus; it is also found in Fresno, Kern, Placer, Riverside, Tulare, and Tuolumne, 13 counties in all. The most important deposits are found in Tulare, Santa Clara, Napa, and San Benito counties. The greater part of the magnesite in California occurs in the form of veins or lenses of variable length and thickness in massive serpentine. Some of the magnesite masses are as much as 30 ft. in thickness, and from this thickness they range to mere stringers and gash veins too thin to work. The Californian magnesite is of the amorphous type.

In Washington, the mineral is crystalline and occurs as massive beds in a sedimentary series in which are found dolomite, shale, and quartzite into which basic igneous rocks have been intruded. The only known deposits are within a radius of 5 to 12 miles south-west of the town of Chewelah, in Stevens county, or about 60 miles north of Spokane.

In Washington regular quarrying methods are employed in getting out the ore. Tunnels are run into the hill at convenient points and rises are put up to the quarry-floor. The ore is allowed to fall through such rises into small cars, which are trammed by hand to the surface. In California, where the veins are often thick and steeply dipping, various mining methods are employed, depending on the thickness and attitude of the veins.

Soon after the war started, nearly every important mine in the West established a calcining-plant, where at least a preliminary burning was carried out. As time went on, methods employed were perfected and facilities for calcination, both in method and capacity of furnaces, are now comparable with those used in Austria before the War. Calcination is effected in different types of kilns: (1) bottle-shaped kilns; (2) vertical kilns resembling lime-kilns; and (3) rotary kilns, like those used in the manufacture of cement. Distillate or crude oil is the fuel in chief use in California, but coke is employed at one plant. The distillate is sprayed with air or steam into the four different compartments of the bottle-shaped kilns, and the waste-heated gases serve to heat the crude ore as it descends from the intake to the reverberatory chambers, where actual calcination takes place. Coke, where used, is mixed directly with the crude magnesite, and its content of ash, therefore, has to be as low as possible. At most plants there is good economy of waste heat, and action is practically continuous in all the different types of kilns. At the up-to-date plant of the Northwest Magnesite Co. at Chewelah, Washington, five rotary kilns are installed and a sixth is on the ground ready to be set up. Powdered coke is the fuel used and the capacity is 60 to 65 tons of dead-burned magnesite per kiln per 24 hours, making a total of 325 tons per day or approximately 10,000 tons per month. When the sixth kiln is installed this will be increased to 12,000 tons per month. The American Mineral Production Co., operating near Chewelah, has shipped its material recently to the plant of the International Portland Cement Co. near Spokane, where it is dead-burned in 165 ft. rotary kilns. In general it may be said that American practice is comparable with foreign practice so far as rotary kilns are concerned. The action in the rotary kilns is continuous. The capacity of the kilns varies according to the different types. The usual practice in the bottle-shaped kilns gives 15 to 20 tons of calcine per 24 hours; in 125 ft. rotary kilns, 60 to 75 tons per 24 hours; and in the vertical kilns, 7 tons per 24 hours. In the bottle-shaped kilns only coarse lump magnesite can be calcined; the fine cannot be used for the reason that it obstructs the draft. In rotary kilns all sizes may be calcined, fine as well as lump. Calcination yields two products. If the burning is carried to the point where 3 to 4% of carbon dioxide is left, the product is referred to as "caustic" and is consumed principally in the flooring trade. Greek magnesite was extensively used in flooring cement prior to the war, and Californian magnesite is now being used in part for this purpose. If burned to the point where it contains only ½% of carbon dioxide by weight, it is referred to as dead-burned; and approximately 90% of the total consumption of the United States is of this kind.

The calcining capacity of the Californian plants is estimated at 10,000 tons per month. In Washington, considering one plant alone, there is a calcining capacity of 10,000 tons per month, making the present available capacity of the country in excess of 20,000 tons per month, or 240,000 tons per year, which is more than ample for present requirements.

The reserves of magnesite in Washington are of much greater magnitude than those of California. If the annual consumption of raw magnesite in the Uuited States be taken as 350,000 tons, the home supply will easily last at least a generation, and there is always the possibility of the discovery of new deposits. No deposits are pure, and magnesite for the trade has to be selected with care, but in this respect home deposits are no different from the more important foreign sources.

Value of Graphite Deposits.—In the *Canadian Mining Journal* for August 6, Charles Spearman, a well known mineralogist, discusses the factors which govern the value of a graphite deposit. The value of a graphite deposit depends firstly upon the physical and chemical properties of the contained graphite; secondly, upon the tonnage and tenor of the ore available for milling purposes; and thirdly upon the process of refining and the market.

Graphite differs from most minerals in that an average assay sample from a deposit may on analysis show a high content and yet the deposit may have a relatively low value when measured by the physical properties as standardized by the consumer. The bulk of graphite marketed goes into the manufacture of crucibles. This grade commands the highest price, and the consumer specifies that the stock shall have a moderately thick flake, shall pass through a standard 16 mesh screen, at least 50% shall pass over a standard 50 mesh screen, and the whole shall pass over a standard 90 mesh screen, and in addition shall contain at least from 85% to 90% or more graphitic carbon, and shall be free from such impurities as lime, iron, mica, sulphur, etc. The foregoing specifications eliminate all the finely flaked or so-called amorphous graphite from this particular demand and classifies it with the lower grades of graphite, with which the market is usually stocked and for which consequently prices are very low. It is, therefore, important that the deposit shall contain distinctly flaky graphite, and that the flakes are not too thin, and of such dimensions that all or practically all shall be larger than that set forth in the specifications of the consumer of the higher grades. The higher the graphite carbon content of such a deposit, the more valuable the deposit.

The quality of the graphite in a deposit should be considered from the chemical as well as from the physical standpoint. If the flake be intimately interlaminated with very thin plates or scales of a micaceous decomposition-product or other impurities, the grade of the refined graphite may be low if the ore is subjected to ordinary ore-dressing just sufficient to liberate the composite flake from the surrounding gangue. Any attempt at further refining may have the desired effect chemically, namely, to raise the graphite carbon content, but it will be done at the expense of lowering the grade physically by creating a thin flake. This thin-flaked refined stock causes a further increase in volume per unit mass of the refined flake and thus renders it less suitable for the purpose of crucible manufacture, and in addition the extra refining usually creates an abnormal quantity of fines or low-grade stock. There are exceptional cases where this enclosed foreign matter has been noted to run as high as 10%. It would be almost impossible to successfully treat ore from such a deposit in order to produce crucible stock, as it would mean the elimination of all the remaining impurities.

SHORT NOTICES.

Diesel Engines for Mines.—In the *Mining and Scientific Press* for September 13, C. Legrand describes the Diesel engines at work at the Burro Mountain mines, New Mexico, belonging to the Phelps-Dodge Corporation.

Cementation.—The *Iron & Coal Trades Review* for October 3 reprints a paper read before the North Staffordshire Institute of Mining Engineers by A. Hassam and T. T. Mawson describing the sinking of an iron-stone mine at Chesterton, Staffordshire, where the Francois cementation process was adopted for sinking through water-bearing strata.

Mining at Braden.—In the *Mining and Scientific Press* for September 20, Frank Cameron describes the method of mining at the Braden copper mine, Chile.

Alaska Gastineau.—The September *Bulletin* of the American Institute of Mining and Metallurgical Engineers contains a paper by G. T. Jackson on mining methods at the Alaska Gastineau gold mine, behind Juneau.

Diamond Mining.—The *South African Mining & Engineering Journal* for September 6 describes F. M. Cox's proposed method of working the Vaal river beds by means of caissons.

Wire Ropes.—In the issue of October 24, the *Colliery Guardian* commences a series of articles on failures caused by defects in winding ropes.

Mining Theodolite.—The *Colliery Guardian* for October 10 describes a new mining theodolite placed on the market by T. Cooke & Sons, Ltd., of York.

Colloids and Flotation.—The *Engineering and Mining Journal* for September 20 contains a review of a number of recent articles and papers on the effects of colloids on flotation.

Wulfenite.—*Chemical and Metallurgical Engineering* for September 15 contains an article by J. P. Bonardi on the treatment of wulfenite, the molybdate of lead, for the production of molybdenum and its compounds.

Electric Zinc Furnace.—The September *Bulletin* of the American Institute of Mining and Metallurgical Engineers contains a paper by Charles H. Fulton on his electric furnace for smelting zinc ores.

Glucinum, or Beryllium.—*Chemical and Metallurgical Engineering* for September 16 contains a paper by J. S. Negru on glucinum, its minerals, compounds, and chemistry.

White Lead.—In the *Chemical Trade Journal* for September 27, James Scott describes his microscopical examination of white lead.

Shasta County, California.—In the *Mining and Scientific Press* for September 20, Herbert Lang continues his account of metallurgical work in Shasta county, dealing with smelter fume and flotation.

Gold Discoveries at The Pas.—In the *Canadian Mining Journal* for September 24, J. S. De Lury discusses the developments of the gold deposits at Copper Lake, north-east of the The Pas, Manitoba. In the issue of October 1, R. C. Wallace writes on the same subject.

Geology at the Front.—The *Geographical Journal* for October reports the paper read before the Royal Geographical Society by Captain W. B. R. King on the geological work on the Western Front.

Chromite in America.—The September *Bulletin* of the American Institute of Mining and Metallurgical Engineers contains a paper by J. S. Diller on chromite deposits in the United States.

Larder Lake, Ontario.—The *Canadian Mining Journal* for September 17 contains an article by N. C. Pearce on the Larder Lake district. As recorded in the October issue of the Magazine, attention has been drawn once more to this gold-mining district by the activities of the Associated Gold Fields Mining Co., for which C. Daimpré is manager.

Wasapika, Ontario.—In the *Canadian Mining Journal* for September 10 and October 7, R. E. Hore writes on recent developments in the Wasapika gold district, Ontario.

Genesis of Quartz in Veins.—G. J. Bancroft, in the *Mining and Scientific Press* for September 27.

Oil Prospecting.—In *Economic Geology* for October, F. H. Lahee writes on geologic factors in oil prospecting.

Mineral Oils.—At the October meeting of the Institution of Petroleum Technologists, Arnold Philip read a paper on laboratory tests on mineral oils.

Oil in West Canada.—In the *Canadian Mining Journal* for September 10, N. C. Pearce gives an outline of the oil developments in Alberta and the North-West Territory.

Scottish Oil.—At the meeting of the Mining Institute of Scotland held on October 18, H. M. Cadell read a paper on Scottish Oil Possibilities,

Diamond Cutting.—*The Times* Engineering Supplement for October contains an article on the diamond-cutting industry founded by Bernard Oppenheimer at Brighton, Fort William, Wrexham, and Cambridge, where wounded soldiers are employed. The article gives an outline of the technique of splitting, cutting, and polishing.

Brown-Coal Furnaces.—The *Industrial Australian & Mining Standard* for August 21 describes and illustrates the boiler furnaces at the Melbourne electric power house, in which Morwell brown coal is burnt.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2. with a note of the number and year of the patent.*

3,415 of 1918 (133,095). NITROGEN CORPORATION and J. C. CLANCY, Providence, Rhode Island. A development of the Bucher method of producing cyanide or cyanamide. Claims: (1) The process of fixing nitrogen in the form of cyanide or cyanamide by causing free nitrogen to react upon an intimate and preferably dry mixture of alkali carbonate, hydrate, or the like, with coke, charcoal, or like carbonaceous material, and a metallic catalyst in finely divided condition, characterized in this, that after an alkali cyanogen compound has been formed in such a mixture, it is extracted from the reaction residues by liquid ammonia, and the residues are returned to the cyanide-forming process for further treatment with free nitrogen. (2) The process according to claim (1) further characterized by the fact that the catalyst-containing mixture to be cyanized is briquetted prior to its treatment with free nitrogen.

5,104 of 1918 (114,316). E. BAUER, Zurich, and O. NAGEL, Vienna. A process for the recovery of gold, silver, and radium from sea-water by adsorption, a colloidal solution of carbon being added, and the carbon then flocculated by means of a positive sol, such as a sol of hydrated ferric oxide.

10,072 and 10,073 of 1918 (133,559 and 132,560). H. W. MATHESON, Shawinigan Falls, Quebec. Methods of preparing and recovering mercury and its compounds in connection with the inventor's method of making acetaldehyde.

10,931 of 1918 (131,964). N. TESTRUP and TECHNO-CHEMICAL LABORATORIES, LTD., London. Continuous furnace used in producing cyanides.

11,688 of 1918 (119,223). G. RIGG, Melbourne. Desulphurizing of sulphide ores in two stages, as described in the Magazine for June, 1918.

13,368 of 1918 (131,998). ELECTROLYTIC ZINC CO. OF AUSTRALASIA, Melbourne. Improvements in the method of removing cobalt compounds from zinc solutions before electrolysis.

13,793 of 1918 (132,842). C. DREYFUS and J. J. BLOCH, Manchester. Method of manufacturing permanganate of potash.

14,246 of 1918 (132,023). NATIONAL LEAD CO., New York. Mechanical rabbling for Scotch ore-hearths used in smelting lead sulphide ore.

14,645 of 1918 (119,038). T. M. CHANCE, Philadelphia. In concentrating ores or washing coal, using water charged with particles of solids, the water thus being of greater specific gravity than water and so affording greater separating power. This method was described in the Magazine for August, 1918.

15,122 of 1918 (119,244). A. and M. HIRSCH, New York. Manufacture of sparking alloys containing cerium or lanthanum.

15,431 of 1918 (132,855). A. C. AUDEN, London. In the production of potash salts from felspars, etc., roasting a mixture of the material with lime and salt, and then treating with steam in a closed vessel, utilizing the residue for the manufacture of cement.

15,540 of 1918 (132,622). F. GROS & BOUCHARDY, Paris. Improvements in the manufacture of calcium cyanamide by the reaction of nitrogen on calcium carbide.

15,830 of 1918 (119,867). J. G. and C. J. G. AARTS, Dongen, Holland. Method of sulphatizing metallic sulphide ores by roasting in the presence of a catalyst such as oxide of iron, which transforms the SO_2 to SO_3 and thus provides the acid for converting the oxides to sulphates.

15,862 of 1918 (119,659). N. BUSVOLD, Holmestrand, Norway. Extraction of bismuth and its compounds free from arsenic, from complex ores.

16,695 of 1918 (133,179). R. W. THOMPSON, Leith, and J. MORRISON, Saltcoats, Scotland. Improved method of coating metal surfaces with lead or its alloys.

19,427 of 1918 (122,623). NORSKE AKTIESELSKAB for ELECTROKEMISK INDUSTRI, Christiania, Norway. Producing pure alumina from clays by heating to a red heat, and treating with nitric acid, and reducing the alumina from the resulting nitrate.

20,292 of 1918 (132,411). O. S. WIGAN and W. GROVER, London. An aluminium alloy that resists the attack of sea water, containing 90% or over of aluminium, and small proportions of tin and copper, and antimony or bismuth.

21,808 of 1918 (132,693). A. GRAUEL, Toronto. Method of extracting potash from felspar, by heating the latter to so high a temperature that the potassium distils off.

1,461 of 1919 (133,236). E. T. GOLDTHORPE, Chicago. In ore-roasting furnaces, placing the ore in cylindrical containers which are mounted on an inclined track, whereby the ore can be conveniently removed and cooled at the end of the roasting operation.

6,456 of 1919 (127,555). L. W. RYAN, Chicago. Treatment of thorium compounds, with sulphuric acid at a high temperature so as to convert the fluoride into an anhydrous sulphate.

6,985 of 1919 (132,724). E. A. LEOPARD, London. A solder for aluminium containing 55 to 65% tin, 26 to 35% zinc, and 7 to 14% aluminium.

7,128 of 1919 (132,984). A. B. CLARKE and H. H. GREGG, London. Aluminium alloy containing small amounts of lead, bismuth, and tin suitable for use in making cooking utensils.

7,418 of 1919 (132,985). W. G. WATKINS, Derby. Improved shapes of grinding bodies used in tube mills.

8,585 of 1919 (129,624). LINDSAY LIGHT CO., and L. W. RYAN, Chicago. Separation of thorium compounds from monazite by reaction with hydrofluoric acid.

11,187 of 1919 (126,628). P. DESACHY, Paris. Improvements in method of simultaneously making zinc sulphide and barium sulphate in the manufacture of paint.

NEW BOOKS

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine* 723, Salisbury House, London Wall, E.C.2.

Summary of Progress of the Geological Survey of Great Britain for 1918. Published by the Ordnance Survey Office, Southampton. Price 2s. 6d.

This volume gives an account of the activities of the Geological Survey during the year 1918, and includes a list of the more important reports made by the Survey to other Government departments on matters which arose during the war. Among the other subjects dealt with are accounts of the oil shale resources of Scotland, the potash-bearing rocks of North Wales, cannel in Great Britain, the ores of lead and zinc in Scotland, and the bauxitic fireclay of Ayrshire. There are also appendixes dealing with the faunal characters and correlation of the concealed Mesozoic rocks in Kent, the fossil plants from the Coal Measures of certain of the Kent borings, palæontological notes on the Donnington bore-hole, as well as accounts of borings at Winterbourne, Gloucestershire, Abbey Mills near Holywell, Kilnsea, Yorkshire, and Gosmore, Hertfordshire.

Cobalt: Its Occurrence, Metallurgy, Uses, and Alloys. By C. W. Drury. Toronto: The Ontario Bureau of Mines.

Low-Grade Mines Commission. Statement of evidence submitted by the South African Institute for Medical Research. Johannesburg: The Transvaal Chamber of Mines.

Base Metal Resources of South Africa. By W. Versfeld. Pretoria: Department of Mines and Industries.

Metallurgy of Zinc. A Bibliography on the Roasting, Leaching, Smelting, and Electrometallurgy of Zinc. Rolla, Missouri: The School of Mines and Metallurgy.

Investments Account Book. By H. A. Randall. Price 8s. 6d. net. London: *The Financial Times*.

COMPANY REPORTS

Burma Corporation.—This company holds nearly all the shares of Burma Mines, Ltd., which works the rich lead-zinc-copper-silver ore deposit at Bawdwin, Upper Burma, particulars of which have been given on several occasions in the Magazine. The report for 1918 shows that the amount realized from sales of lead and silver was £913,696, against £739,577 for the previous year, and the total receipts £1,008,244, against £796,227. The operating expenditure in Burma amounted to £591,277 in 1918, against £479,[illegible] in 1917, which, notwithstanding the greatly increased cost of supplies and the innumerable difficulties in working caused by the war conditions still prevailing as well as by an epidemic of cholera and influenza, shows a satisfactory decrease in the ratio of expenditure to the total receipts, the figures being for 1918 59% against 60·24% for 1917. The amount receivable by the corporation from Burma Mines, Ltd., was £181,480 against £144,108 for the previous year. The greater part of this amount has been advanced to Burma Mines, Ltd., to meet capital expenditure, increasing the total advances made by the corporation at December 31, 1918, to £585,004. Developments at the mine have continued satisfactory, and the ore reserves at the end of 1918 were 4,404,000 tons, assaying 24·1 oz. silver per ton, 26·2% lead, and 18·4% zinc. The work during the year on the Shan lode has developed a fair-sized copper ore-body, high in silver, and the reserves include 283,000 tons of this copper ore, assaying 21·6 oz. silver, 14·2% lead, 8·7% zinc, and 10·2% copper. The tonnage developed during the year amounted to 324,869 tons, a considerable amount when taking into consideration the large footage of driving and cross cutting necessary to connect the Chinaman and Shan ore-bodies and to block out the ore. These two ore-bodies are now connected by good haulage-ways on the 653 ft., 430 ft., and 300 ft. levels. The northern extension of the Shan lode as far as developed has turned into copper ore, high in silver, and from the indications below and on the surface it is believed that any ore-bodies to the north will also be of this nature. The country to the north is very favourable. The "Gold Hole," which contains a copper ore-body, is still 1,400 ft. north and 800 ft. east of the most northerly working. During 1918 the smelter and refinery produced 18,641 tons refined lead and 1,970,614 oz. refined silver. In the first half of the year the estimated production of lead was nearly attained, and the production of silver was exceeded, but unfortunately operations were entirely upset by cholera and influenza epidemics which started in August, and the effects of which in the operations of the smelter lasted to the latter part of November. The board have recently discussed the question of increasing the smelter output with R. G. Hall, the resident manager, who came to England for the purpose. After discussion with Lawrence Addicks, the consulting engineer, it has been decided that an entirely new and modern lead-smelting plant and reduction works of a capacity to produce 60,000 tons of lead and 5,000,000 oz. of refined silver per year should be erected at Namtu. Plans of the new smelter and refinery are now in progress, and the preliminary steps in connection with the erection of the plant have already been taken. Owing to the careful consideration and investigation necessary on account of the introduction of a new industry to Indian labour and conditions, progress with the Indian zinc-smelting works has not been rapid. Plans for a plant to deal with 10,000 tons of spelter and 30,000 tons of sulphuric acid per year have now been got out. The preliminary steps have been taken for the erection of works at Jamshedpur, adjacent to the works of the Tata Iron and Steel Company, the sub-lessors of the site, and tenders are now being invited for the supply of the necessary plant and machinery. Steps are being taken for the formation of a new company in India to take over the Bawdwin mine from Burma Mines, Ltd. The new company will be incorporated under the Indian Companies Acts, and will have a capital of 18,000,000 shares of 10 rupees each, of which 13,531,182 will be issued fully paid to Burma Mines, Limited, as the purchase price, the remainder being held in reserve. These arrangements when carried through will entitle the shareholders in Burma Corporation to receive 14 shares in the Indian company for each share in the corporation. Reference to the corporation's new smelting campaign is made in the Editorial columns.

Renong Dredging.—This company was formed in 1908 to acquire alluvial tin deposits on the Renong and Pakchan rivers, in the Western States of Siam. As has previously been recorded in these pages, the company is the pioneer of the English tin-dredging enterprises in the East, and the credit is due chiefly to E. T. McCarthy for its inception. F. W. & R. Payne are the consulting engineers, and Frank Nicholls is general manager. The report for the year ended June 30 shows that No. 3 dredge resumed operations in December, as it was then not necessary to conserve spares any further. Dredges Nos. 1 and 2 were not at work for 2 and 2½ months respectively during overhauls, and they were also out of commission during part of the influenza epidemic in October and November. The total ground treated by the three dredges was 1,577,374 cu. yd., and the total output of tin concentrate 759 tons, equal to 1·08 lb. per yard. The receipts were £122,248, and the net profit £41,300, out of which £3,750 has been distributed as preference dividend, and £21,816 as ordinary dividend, the latter being at the rate of 25%. The company is examining a new area of dredging ground in Selangor, Federated Malay States.

Kinta Tin Mines.—This company was formed in 1900 to acquire alluvial tin properties on the eastern side of the Kinta valley, Perak, Federated Malay States. W. A. Luning is the chairman and Osborne & Chappel are the managers. Satisfactory dividends have been paid regularly. Five years ago the company joined with Gopeng in a scheme for obtaining water at higher pressure from the Kampar River. The report for the eighteen months ended December 31, 1918, shows that 742 tons of tin concentrate was won, realizing £121,663, and that the working profit was £85,738. From this profit £46,880 was deducted for depreciation, income tax, and excess profits duty. The shareholders have received £36,000, being at the rate of 30%, free of income tax, for the 18 months. The company has recently acquired an interest in the Tyndrum Mines, Ltd., which works lead-zinc mines in Perthshire, Scotland.

Philippine Dredges.—This company was formed in Melbourne in 1912 to acquire alluvial gold ground on the Paracale river, Luzon, Philippine Islands. The company also owns a majority of the shares of the Paracale Bucket Dredging Co., operating ground adjoining. John Mc Whee is chairman, and William Telford is manager. The report for the year ended October 31, 1918, has just arrived in this country. This shows that the two dredges of the Philippine Dredges Co. treated 527,606 yards and 490,376 yards, winning 4,894 oz. and 2,112 oz. respectively. The two dredges of the Paracale Co. treated 259,373 yards and 555,287 yards, winning 1,405 oz and 3,961 oz. respectively. The profits from the company's dredges were £7,705 and the dividends received from the Paracale Co. were £4,853. After the payment of administration and other expenses, the divisible profit was £4,183. Dividends absorbed £8,730, or 5%, being partly paid out of the profits brought forward from the previous year. Operations were greatly impeded by inability to effect repairs, and since the close of the year under review one of the Philippine Co.'s dredges and one of the Paracale Co.'s dredges have suspended operations until necessary repairs are made.

Broken Hill Proprietary.—Cabled information relating to the accounts for the year ended May 31 was published in the September Magazine. The printed report is now to hand. Operations at Broken Hill were hindered by shortage of coal caused by a strike of engine-drivers at the port, and afterward by the general strike which started on May 5 and still continues. The output of zinc-lead-silver ore was 142,488 tons, including 22,061 tons of silicious ore sent direct to the Associated Smelters. The lead concentrator treated 120,095 tons of ore for a yield of 19,339 tons of concentrate averaging 57·35% lead and 27·63 oz. silver per ton. The zinc flotation plant treated 211,438 tons of tailing for a yield of 48,579 tons of zinc concentrate. The whole of the current slime, 136,906 tons, was treated at the Bradford flotation plant, where 15,263 tons of lead concentrate, averaging 55·7% lead and 83·2 oz. silver, and 35,135 tons of zinc concentrate, averaging 51·08% zinc, were produced. Details of the company's iron and steel business at Newcastle and of the dividends have already been given in our pages. The accounts do not deal with the Broken Hill and Newcastle businesses separately.

New Modderfontein.—The property worked by this company has good claim to be considered the premier mine of the Rand at present. The report for the year ended June 30 last shows that 1,016,017 tons was raised, and, after the rejection of waste, 920,500 tons averaging 10·6 dwt. per ton was sent to the stamps. The yield of gold by amalgamation was 324,394 oz. and by cyaniding 158,203 oz., making a total of 482,597 oz., worth £2,018,902, or 43s. 10d. per ton milled. The working cost was £929,011 or 20s. 2d. per ton, leaving a working profit of £1,089,891 or 23s. 8d. per ton. Owing to the southern shaft and the new treatment plant coming into operation the tonnage was 236,000 greater than during the previous twelve months and the profit £256,500 higher. The shortage of labour has, however, prevented the working of the new plant to its full capacity. The dividends absorbed £875,000, being at the rate of 62½%. The reserve is estimated at 8,854,300 tons averaging 8·5 dwt. Owing to scarcity of labour, development has been considerably restricted, but in view of the large reserve this class of work is not pressingly required. From an inspection of the figures for the content of the reserve and the ore mined during the last few years, it is clear that the recent developments have added much high-grade ore.

Nourse Mines.—This company was formed in 1894 as the Nourse Deep, and operates a property in the central Rand. The control is with Rand Mines, Ltd. Mining is rendered difficult by an unusual number of dykes and faults. The report for the year ended June 30 shows that 519,009 tons was raised, 234,843 tons coming from the Main Reef Leader, 218,110 tons from the South Reef, and 66,056 tons from the Main Reef. After the rejection of 11% waste, 457,800 tons averaging 6·65 dwt. gold per ton was sent to the stamps. The yield by amalgamation was 97,144 oz. and by cyaniding 50,902 oz., making a total of 148,046 oz., worth £619,228, or 27s. 1d. per ton. The working cost was £607,937, or 26s. 7d. per ton. The reserve is estimated at 1,526,100 tons averaging 6·8 dwt., the position as compared with the previous year being virtually unchanged as regards both tonnage and assay-value. Plans have recently been completed for developing the south-eastern section of the mine. The Eastern South Nourse No. 1 shaft is to be re-equipped and sunk an additional depth of 1,000 ft. to 3,500 ft. Eventually all hoisting operations will be concentrated at the two South Nourse shafts.

Glynn's Lydenburg.—This company was formed in 1895 to acquire a gold mine on the Sabie river near Pilgrim's Rest, in the Lydenburg district of the Transvaal. The control is with the Central Mining group, and G. C. Damant is manager. The report for the year ended July 31 last shows that operations continued to suffer from the effects of the floods in the previous year, and that the influenza epidemic also had an adverse effect. The output in consequence showed a decrease, while the costs increased. The total ore treated was 37,982 tons averaging 9·5 dwt. per ton. The yield by amalgamation was 7,142 oz., and by cyanide 9,724 oz., making a total of 16,866 oz. worth £70,309, or 37s. per ton. The working cost was £63,321, or 33s. 4d. per ton, leaving a working profit of £6,988, or 3s. 8d. per ton. The shareholders received £8,500, or 5%. The ore reserves stand at 108,546 tons averaging 9·4 dwt., as compared with 138,928 tons averaging 9·8 dwt. the year before. The decrease is due to comparatively little development having been done.

Willoughby's Consolidated.—This company was formed in 1894 to consolidate various land and mining interests in Rhodesia controlled by the late Sir John Willoughby. The control is with the British South Africa Company. The only dividend was one of 5% paid in 1910. The report for the year 1918 shows that at the Eiffel Blue mine 14,502 tons of ore yielded gold worth £23,614. This mine is now nearing exhaustion. The royalty derived from the tributing of the Connemara and other mines was £510. The company holds interests in the Matabele Queen's and Eileen Alannah companies. The property of the former has been abandoned and that of the latter, after being closed in June, 1918, was reopened later in the year on a smaller scale. The company's revenue from mining operations, after payment of all expenses, was £3,097, the total revenue, chiefly from land and farms, etc., was £33,534, and the net profit was £15,616. Against the profit has to be put £14,000, the amount written off for bad debts in London.

Niger Company.—This company was formed in 1882 as the National African Co., and from 1886 to 1900 held a Royal Charter empowering it to govern the territories in the basin of the River Niger, West Africa. In the latter year the British Government took over the administration, and the company continued the general mercantile business. Tin mining is one of the company's many interests. Most of the tin land is worked by other companies, which pay royalty, but certain properties are operated by the company, under the management of Laws, Rumbold & Co. The report for 1918 shows that mines worked by the company produced 530 tons of tin concentrate, out of Nigeria's total production of about 8,000 tons. The company has acquired controlling interests in the Ribon Valley and Zuma Tin Areas companies, and in several smaller mining companies. The company's profits for the year were £374,115, of which £123,490 came from mining business and £250,625 from general trade.

Pena Copper Mines.—This company was formed in London in 1900 to acquire a pyrites mine in the south of Spain that had for a few years previously been worked by a Belgian company. Small dividends were paid from 1903 to 1906. John F. Allan is consulting engineer. The report for the year 1918 shows that, owing to difficulties in connection with freights and marketing pyrites, the output and deliveries were much under normal. The amount of ore raised was 91,827 tons, as compared with 160,121 tons the year before. The ore added to the leaching heaps was 49,493 tons, and the remainder was prepared for export. The shipments totalled 72,023 tons, comprising 5,458 tons of cupreous ore, 24,822 tons of non-cupreous ore, and 41,742 tons of washed ore. The production of fine copper in precipitate was 554 tons. The profit and loss account showed a working profit of £20,925, but against this had to be charged £17,495 for administration, taxes, etc., and £10,384 for interest on loans raised on mortgage. The reserve of proved ore at the end of 1918 was 3,454,718 tons, as compared with 3,730,022 tons the year before.

The Mining Magazine

W. F. WHITE, *Managing Director*. EDWARD WALKER, M.Sc., F.G.S., *Editor*.

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938*. Telegraphic Address: *Oligoclase*. Codes: *McNeill*, both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago. 2,222, Equitable Building, New York.

SUBSCRIPTION: U.K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XXI. No. 6. LONDON, DECEMBER, 1919. PRICE ONE SHILLING

CONTENTS.

EDITORIAL

WE are glad to welcome once more the *Camborne School of Mines Magazine*, which has resumed publication. Most of the reading matter is naturally of the social order, and helps to preserve the esprit de corps; even the technical article, "Hints to Would-be Mine Surveyors," deals with the human side of the business. All old students should get into touch with the editor, Mr. S. R. Prisk.

AS recorded last month, the publication of our New York technical contemporaries was suspended at the end of September owing to a strike of machine-room hands in the printing department. The publishers have made new plans for production. The *Engineering and Mining Journal* is now printed at San Francisco, and the issue of October 4 is to hand. *Chemical and Metallurgical Engineering*, which has been converted from a semi-monthly to a weekly, is printed at Cooperstown, New York State.

ABNORMAL credits, both public and private, have caused British and Continental paper to drop to a discount in the United States and other producing countries. Consequently gold and silver are at a premium. Gold is now worth 105s. per oz., and silver 75d., in paper. The decrease in the output of these metals is a factor in the situation, and as regards gold a continual decrease is to be expected. The available sources of silver are severely restricted, Mexico, Broken Hill, and the argentiferous copper producers in America all giving anxiety to the buyers.

THE average British citizen takes little or no interest in the political questions of the Overseas Dominions. It is not surprising therefore that most folks here are quite unaware of the plans for giving the people of India a large share in the government of their country. Yet this rearrangement of responsibility for the welfare of that great empire is a step of supreme importance. It is not too much to say that its success depends entirely on the good will of every section of the community. There have been many signs of discontent with the measure among certain Anglo-Indians, particularly in the civil services. The gravity of the situation and the possible serious effects of such unrest are fortunately recognized by many men connected with India. In particular it may be mentioned that Sir Thomas Holland has decided to renounce a new appointment in England and return to India with the express purpose of inspiring the services to accept the situation and adopt a public-spirited attitude. Sir Thomas has done much for India in the past, chiefly in connection with the development of her mineral resources. His present action will still further increase the nation's gratitude to him.

THE importance of the mining geologist is being gradually recognized. The latest example of this new order of things is to be found in the appointment of Mr. V. H. R. Murray as underground manager of the Golden Horse-Shoe mine. Mr. Murray knows the mine well, for he has hitherto been the surveyor and geologist to the company. He stands high in the estimation of his fellow engineers, as is evidenced by the fact that he has been elected honorary secretary of the newly formed West Australian Committee of the Institution of Mining and Metallurgy.

BY the time these lines are in print, the second volume of Mr. E. T. McCarthy's "Incidents in the Life of a Mining Engineer" will have been published. This book will form an appropriate Christmas gift among mining engineers and their friends. Many will consider the second volume of even greater interest than the first, for the particular reason that it covers experiences of more recent date. His outspoken disclosures as to the false cry of "Chinese Slavery" on the Rand may be mentioned as an attractive feature of the new reminiscences. As before, the profits accruing will be devoted to St. Dunstan's Hostel for Blinded Soldiers. That institution benefited by nearly £800 from the proceeds of the first volume, and it is to be hoped that an even greater amount will be forthcoming from the second. The price is 15s., by post 15s. 6d., but buyers might well send Mr. McCarthy a guinea in order to swell the profits.

PROMOTERS of public companies do not always issue a prospectus, but form a market privately instead. Thus the buyer of shares has nothing to go on except rumour or his personal belief in the promoter. Of course, the promoters of many prospectusless companies are beyond reproach; the only grievance against them is that their respectability is aped by men of less account. The new regulation of the Committee of the Stock Exchange requiring all such companies to advertise details in at least two leading London morning papers before leave to deal in the shares is granted, will be generally welcomed by investors. According to the new rule, the directors have to assume responsibility, collectively and individually, for the information advertised. Hitherto nobody has been responsible for statements made in connection with the sale of this class of share. The details to be published must include statements by the chairman or secretary relating to the following items: the capital, authorized and issued; borrowing powers and the extent to which they have been exercised; date and particulars of incorporation; names and addresses of directors, bankers, auditors, and secretary; objects of the company, and nature of its business or particulars of property acquired; material conditions relating to the formation of the company and the flotation of the issue. By means of this welcome reform, many hole-and-corner makings of markets will be rendered impossible, and the stopper will also be put on the plans of some of the more eminent houses who sail close to the wind.

DURING the past few months the London daily press has published a number of brief paragraphs announcing marvellous discoveries of gold in the region of the earth vaguely known to journalists as the Great North-West. Some of these paragraphs have referred to a new Klondyke, and others have located the deposits in Alaska. Owing to the scantiness of information coming through to London, it has not been possible hitherto to trace the rumours to their source. This month, however, reliable news is to hand, and particulars are given in another part of the issue. The mine that has caused the sensation is known as the Premier, and it is situated in British Columbia, at the head of the Portland Canal, which here forms the international boundary between Canada and Alaska. The Treadwell mines are 250 miles to the north-west, and the Anyox copper mine is 50 miles to the south. The chief minerals in the ore are auriferous pyrites and argentite, and the values of the gold and silver contents are about equal. The method of treatment would appear to consist of concentration and smelting. As consignments of picked ore have been shipped to smelters, and seeing that the Guggenheims are acquiring control, this view of the commercial nature of the ore may be held to be correct. The history of the development of the deposit affords one more example of the romance of mining. Several pioneers had been precious near the rich ore without knowing it. Thus is attention again drawn to two axioms of mining: optimism and perseverance are requisite to success; and it is as hard to strike a bonanza as to hit an enemy's aeroplane on a dark night.

ANNOUNCEMENT has been made that the Geological Survey of Great Britain has been transferred, for administrative purposes, from the Board of Education to the Department of Scientific and Industrial Research. Attention has often been drawn in these pages to the anomalous position of the Geological Survey. The new move may prove helpful, but there is no particular reason for indulging in any such hope. The present position with regard to the minerals of the country and the empire seems to be if anything more complicated than ever. The care of the industry is now under six different departments. The Imperial Mineral Resources Bureau has been formed to collect statistics and records throughout the world; the Home Office is responsible for the regulation of mining operations in this country; the Mineral Resources Department of the Ministry of Munitions has been made a department of the Board of Trade, and the reports on mineral deposits, prepared by so many practical mining men, are pigeon-holed instead of being handed over to the Geological Survey or the new Bureau; the Survey is, as now announced, under the Department of Scientific and Industrial Research; the Imperial College of Science and Technology is under the Board of Education; and the Imperial Institute, a publisher of a number of excellent handbooks on economic minerals, is controlled by the Colonial Office. No doubt all or most of the above will be transferred eventually to a Department of Mines; the sooner the better.

Chances in West Australia.

When Mr. C. M. Harris introduced his paper on Prospecting in West Australia at the October meeting of the Institution of Mining and Metallurgy, he gave an outline of the advice which experienced mining geologists could give to prospectors as to the country deserving particular attention within the limits of that State. Though the information Mr. Harris gave was intended primarily for the benefit of the prospector, it will be of considerable help here in following the news of discoveries and developments in the field or on the mine and in judging of the general influence of these discoveries. We therefore quote from his remarks herewith. The mineral deposits of the State, particularly the gold deposits, are mainly associated with greenstone rocks, although the granite magma probably played a large part in the introduction of gold and other metals. Thus prospecting is likely to be successful if it is devoted to the greenstone areas, particularly those portions in the neighbourhood of the granite, and where the rocks have been sheared and altered. Many of the lines of shearing are now occupied by quartz lodes and jasper bars. The greenstones of economic importance may be classified into two divisions. The first division consists of fine-grained basaltic dolerites, now largely represented by epidiorites and still more altered forms. These are among the oldest rocks of the State, and are well developed at Kalgoorlie, where the more altered forms are known as calc-schist. They carry auriferous lodes, which are, however, not as rich or consistent in their gold content as those of the second group, which consist of plutonic dolerites of coarse or medium grain. These latter rocks form the greater portion of the greenstone areas of the State. They are, like those of the first group, largely represented by epidiorites, but are of much coarser grain. By far the greatest proportion of the gold-bearing lodes are found in the rocks of this division. In the second group should also be included the ultra-basic rocks such as the peridotites and their derivatives, the serpentines. These are fine-grained dark green or almost black rocks, softer than the fine-grained epidiorites. So far few auriferous lodes have been found in these ultra-basic rocks, most of those that have been found being in the Eastern goldfields. These rocks, however, should be examined for asbestos, magnesite, and copper ores. The greenstones, particularly those of the second division, are in many localities intersected by porphyrite. Although the main areas of the porphyrite appear to contain few lodes, the neighbourhood of the smaller dykes should be well prospected. These dykes are common at Kalgoorlie, where they seem to be closely associated with the lode formations. Gold is found in other country than the greenstones. For instance, the lodes at Westonia occur in a lens of gneiss, which consists of a foliated quartz-mica-hornblende rock, intermediate between a quartz dolerite and a basic granite. Lodes carrying gold in profitable quantities are seldom found in the granites, but the aplite and pegmatite dykes, and the marginal portions of the granite as well as the lodes themselves should be examined for molybdenite, wolfram, scheelite, bismuth, tin, and the rarer minerals.

Magmatic Waters.

In an article entitled "Water in Rock Magmas and Veins," published in this issue, Dr. J. Morrow Campbell returns to the subject of the origin of tin and wolfram ores, and discusses also some aspects of Mr. W. H. Goodchild's theory of the evolution of ore deposits from igneous magmas. These two themes of his article are no doubt entirely distinct, yet they form a consecutive argument in connection with the matter immediately in hand. As regards the function of the water in magmas, the author is sceptical of it ever having been an original constituent, but holds that it entered its composition after a sufficient degree of cooling had been reached, the water being in fact meteoric water which percolated downward through crevices. His argument is that at the original high temperatures of the earth no hydrate could exist. We are not sure that we follow this line of thought, for it would appear that the sulphur constituent of the magma would also have to be considered, and there can hardly be any doubt that both water and sulphur would be held in combination by the pressure of overlying material. Dr. Campbell goes much farther back in the history of the world than Mr. Goodchild, and takes a universal magma instead of a local one. Though not fully following Dr. Campbell, we must confess that the usual theories of magmatic waters leave much to the imagination, when water is supposed to have been an original constituent. On the other hand, when the appearance of magmatic waters is assumed to be the last stage of an expiring local volcanism, there is less difficulty in accepting the idea, especially from Dr. Campbell's point of view. It is well, in the study of all these questions, to keep an open mind. We are discussing the action of forces of which little or nothing is known, and theories must never be taken as being more than tentative suggestions containing here and there some grain of truth. With this attitude of mind uppermost, a perusal and study of Dr. Campbell's outline of the history of the earth will prove helpful.

As regards the second theme in his article, it may be said that Dr. Campbell is frankly an iconoclast when the pneumatolytic theory of the origin of tin is in the arena. In his previous paper, published in the issue of February last, he proved the existence of soluble tin compounds, and he was therefore able to argue that the oxides of these metals were carried in solution by the quartz-water mother liquor at high temperatures. His theory is that the water did not reach the granite magma until comparatively late in its history, and that the quartz-water leached the tin and wolfram from the magma and redeposited them around its periphery. The champions of pneumatolysis are disconcerted by the fact that at Tavoy the tin veins carry no tourmaline, the mineral on which the pneumatolytic theory mainly rests, while fluor-spar and apatite are very rarely seen. This fact gives Dr. Campbell an opening for his theory, and other geologists familiar with conditions at Tavoy have also suggested alternative explanations.

Sulman on Flotation.

When Mr. H. F. Picard was elected president of the Institution of Mining and Metallurgy last March we said that a thousand years hence the text-books will still refer to the Sulman-Picard-Ballot patent, and that the name of the new president will in this way be preserved, long after the rest of us have been forgotten. This prophecy of the happy preservation of the names has been made an absolute certainty by the publication of a treatise on the theory of flotation by Mr. H. Livingstone Sulman, the treatise taking the form of a paper read before the Institution. The paper occupies a hundred pages, and to those unacquainted with modern physics it is undoubtedly stiff reading; but it is simplicity itself compared with the larger and more complete exposition of the problem which Mr. Sulman and his co-workers have in hand. The principles on which froth flotation is founded are not usually understood by the average engineer, as was evidenced by the confessions of several speakers at the meeting. Molecular forces, surface tension, adsorption, colloid chemistry, and such like phenomena are outside the usual range of study of the practical man, and are as much in the nature of a mystery to him as Einstein's theory of the universe. He is accustomed only to big forces and is unaware of the existence of small molecular actions. Though he often sees the bubbles and even the balanced spoon attracted to the side of his tea-cup, and watches the spherules of water run along the clear surface of a fountain basin, he does not comprehend their meaning. Many engineers will not feel called upon to undertake a new line of thought, but there can be no doubt that the coming generation, especially the University students, will have to familiarize themselves with the minute forces of nature. Those who desire to obtain an insight into the general principles cannot do better than take Mr. Sulman's paper as a text-book, for, besides being sound in its science, it shows at once the practical application of the principles to commercial enterprise.

Among the speakers contributing to the discussion were Professors Truscott, Carpenter, Louis, and Boys, while Professor Edwin Edser, who has been a collaborator of Mr. Sulman's during the last few years, elucidated several points raised in the discussion. Among other things, Mr. Edser said that the action of the lungs in expelling particles of dust was essentially that of a froth-flotation cell, and he advised that the problems of miners' phthisis might receive some aid from the flotation expert. There were a number of points in the paper which deserved more attention than they could possibly receive during the limited time available. One of these is the explanation of the fact that all materials are floatable to a greater or less degree, and that substances can be arranged in order of relative floatability in the same way that they can be placed in electro-positive and electro-negative order. Quartz can be floated, and fluor-spar and barite are non-metallic minerals that easily rise. Copper carbonates are now being successfully floated at Bwana M'Kubwa, as was recorded in the last issue of the Magazine. Cassiterite is also floatable, but it is difficult to obtain a clean separation from gangue minerals which rise with it. During the last month or two, however, the East Pool engineers have found a suitable selective reagent, as recorded elsewhere in this issue.

The meeting was unusually well attended; in fact the room of the Geological Society was packed to overflowing. It was easy to see that everybody had a high personal regard for the author, and the meeting was truly a great triumph for him. And here it is appropriate for us to say that the reading of the paper has been delayed many years owing to the litigation in connection with Minerals Separation's patents. In the meantime other investigators have published views and theories, and they and their friends have prided themselves that they knew more of the physics of the process than the original patentees. But though Mr. Sulman never wrote anything on the subject, he was immersed in study and research from the beginning. A dozen years ago the present writer saw a book which Mr. Sulman had ready for publication. All the diagrams figuring in the paper were in this book, as well as the word "hysteresis," which Professor Boys said the other night was invented three years ago.

Naturally much research has been done since then, and the services of the principles of colloid chemistry and adsorption have been requisitioned. But the fact remains that Mr. Sulman was a pioneer in the scientific study of the physics of the process as well as an inventor of the successful process.

Now that every one has accepted flotation as an accomplished fact, it is almost impossible to believe that in the early days the proposed methods were received with incredulity. In America, particularly, the processes were practically ignored. Many eminent authorities there looked askance at the English inventors, and regarded them as charlatans on the level of gold-brick merchants and bunco-steerers. The present writer sent an article on oil flotation to the *Engineering and Mining Journal* in 1899, but the late Richard P. Rothwell returned it with the comment: "Heavy minerals don't float; do not write articles for the E. & M. J. after a champagne lunch."

The Conservation of Oil.

The members of the Institution of Petroleum Technologists who attended the meeting held on November 18 were treated to a type of address unusual among the staid scientific and engineering societies. Admiral Dumas presented a paper on the conservation of the world's resources of oil. His language rode the whirlwind; he belaboured everybody for laxity and ineptitude on every possible score; and in his capacity for interjecting "damns," "for God's sakes," and "to hell withs," he fairly outdistanced Lord Fisher. His theme throughout the paper was waste: waste in mining, waste in storing, waste in refining, waste in distribution, waste in use, and waste of brains all the way through. It was a heavy indictment, and the leaders of the oil trade and oil technology who formed the audience at first sat aghast. Before he had finished, however, it dawned upon his hearers that, though his language was full of the breezy exaggerations of the naval commander, there was a sound foundation of common sense in his remarks. For ourselves, we consider the paper worth preserving if only for his admission, in his capacity as secretary of the Royal Commission on Oil Fuel and Engines, that there is a shocking waste of fuel oil and petrol in the military, naval, and air services. No doubt, also, the producers will forgive him for his severe criticisms of their methods, seeing that he was equally ready to flog the backs of the offenders in his own Departments.

It is not necessary to examine Admiral Dumas' statements in detail, for all oil men are fully aware of the many wastes that occur. The most serious of all, of course, arises from the promiscuous drilling of wells; but here, unfortunately, the efforts of the capitalist in impressing governments with the necessity of controlling the drilling campaigns are usually met with the cry of "monopolist" and "profiteer," and the agitation on the part of the producers for economy is thus unwarrantably stultified. Similarly, we need not examine the Admiral's diatribe with regard to the alleged lack of oil instruction at the Universities, except to express the hope that he will be able to induce the oil kings to endow a chair of economic geology at Cambridge.

The most important of the Admiral's pleas was that oil and petrol should never be used when any other fuel or method of locomotion is available. He deplores joy-riding, and includes in this term a great many applications of oil and petrol not usually associated with this reprehensible practice. He goes so far as to say that the use of oil or petrol should be severely restricted, and that it should be the subject of licence to be granted by some central authority.

Undoubtedly the world's oil resources are far and away less than those of coal, and geological inquiry does not lead to any optimistic expectation of indefinite continuance of discovery. Possibly alcohol may prove to be a successor to petrol, and both light and heavy oils may eventually be made from coal and other deposits on a commercial scale. Powdered coal has many of the advantages of oil in connection with steam-raising, though, as it must be used almost immediately after comminution, owing to the tendency to spontaneous combustion, it would not be applicable on board ship. There is another alternative fuel to which attention should be devoted, that introduced by Mr. Lindon W. Bates, and known as colloidal fuel. Brief notice was made of this fuel in our issue of May last, when we mentioned that it had been applied in the American Navy. Mr. Bates finds that petroleum will easily hold in permanent suspension 35% of pulverized coal, and that this mixed fuel can be used in the ordinary oil-burners of steam-raising furnaces. Such a fuel could be safely stored on shipboard, and would thus have the advantages of oil without the disadvantages of pulverized coal. Its use would undoubtedly be an important factor in the conservation of oil supplies. We commend it to the attention of Admiral Dumas and of the leaders in the mercantile marine of this country.

REVIEW OF MINING

Introduction.—The financial position of the country, in connection particularly with foreign exchange, and the increase in prices of silver and gold, have occupied chief position of interest during the past month. Exports of manufactures from this country are, however, gradually increasing month by month, so that the outlook is improving. The lagging of development at mines during the war is beginning to show its effects, the case of the Mysore mine being an outstanding example. The demonstration of the flotation of cassiterite on a commercial scale at East Pool is a promising item in metallurgical progress. The Mexican political situation has received increased attention and American intervention is once more discussed. In the meantime English companies operating or intending to extend their activities in that country do not appear to be greatly worried by adverse conditions. The prices of tin, lead, and zinc show a steady advance.

Transvaal.—The labour problem continues to exercise all the ingenuity of the recruiting agents, who are anxious to stem the steady though slow decline. The offering of a bonus to those renewing on the expiration of their terms has had no results. The Association is now trying to induce the natives to make their period of absence three months instead of six. But the great drawback to the natives endeavouring to make themselves more efficient still exists, that is to say, the little scope offered them to improve their position and wage-earning capacity.

Arrangements are being made for the re-opening of the Sheba group of gold mines at Barberton. A new company is to be formed, with a capital of £330,000, divided into 1,200,000 shares of 5s. each. Of these shares, 1,084,954 are to be issued credited with 4s. paid and offered to present shareholders, share for share. The issue has been underwritten at 5% on the liability of 1s. per share, so the company will start with £50,000 of new capital.

The Witbank Colliery Co. is about to capitalize its reserve, which was formed out of past profits and put back into the business. For this purpose 140,000 new shares of £1 are to be created, and issued as a bonus to present shareholders. The capital will thereby be raised from £210,000 to £350,000. The company has paid dividends of 25 to 30% for some years, and the reserve of coal is sufficient to last 30 years.

Diamonds.—The Minister of Mines of the Union of South Africa has announced that control of the African output of diamonds has been arranged between the four groups of producers with the approval of the Union Government and representatives of South-West Africa. Under this arrangement the world's markets will be supplied by De Beers as regards 51%, the Premier 18%, Jagersfontein 10%, and the South-West Protectorate 21%. The disposal of the diamonds is to be effected through a London syndicate. The Minister stated that the sales of South-West diamonds were at present at the yearly rate of £2,500,000.

The prosperity of the diamond trade is exemplified by the results at De Beers during the twelve months ended June 30. The sale of diamonds brought an income of £5,849,552, and £2,740,000 was distributed as dividends, being 40% on the preference shares and 80% on the deferred shares. This rate of deferred dividend is the highest yet paid. At the present time the diamond trade is showing a continuous advance, and the profits to the De Beers and other companies are increasing still further.

The venture of Mr. Bernard Oppenheimer in founding diamond-cutting works in Great Britain, where wounded soldiers are employed, has been highly successful. A company called the Bernard Oppenheimer Diamond Works, Ltd., is being formed, the capital being £1,300,000. This capital has been subscribed by Lewis & Marks (Diamond Branch), Ltd., but 400,000 of the shares are being taken at par by the South African Diamond Corporation. To provide the funds, 200,000 new shares of £1 each are being issued by the corporation and are offered to shareholders at £2 each. Over 500 men are employed at Mr. Oppenheimer's works at Brighton, and ultimately the number is to be increased to 1,500. The other works are at Wrexham and Fort William, and there is a training centre at Cambridge. This scheme was inaugurated in the middle of 1917, and the profit-earning stage began in February last.

Rhodesia.—The output of gold during October was reported at £204,184, as compared with £223,719 in September. Comparison with October of last year is not helpful, as the influenza epidemic was then at its height. In October 1917, the output was £289,978, in October 1916, £325,608, and October 1915, £339,967. Globe & Phœnix is an unsettling feature of the Rhodesian market, both ore treated and assay-value being down, for the reason given last month. Other outputs in Southern Rhodesia during October were: silver 13,009 oz., coal 47,153 tons, copper 234 tons, asbestos 936 tons, diamonds 24 carats, arsenic 37 tons, and chrome ore 204 tons.

Congo.—The chief business at the annual meeting of Tanganyika Concessions, held on the 3rd of this month, was the granting of sanction to create 1,200,000 new shares, of which 1,000,000 are to be offered to shareholders at the rate of one share for every share now held. This issue has been underwritten by the Imperial and Foreign Corporation, of which Mr. Herbert Guedalla is chairman. This underwriting of the issue was secured for the company by Sir Cecil Budd, managing director of the British Metal Corporation, which handles the output of the mines. The funds raised by this issue will be devoted to redeeming the debentures. Another item of rearrangement of financial interests effected at the meeting consisted in the issue of 200,000 shares to Mr. Robert Williams, the founder and mainstay of the company, in exchange for his rights to amounts equal to 10% of all cash and other assets distributed among shareholders. The company has received during the past year £521,354 in the form of dividends paid by the Union Minière du Haut Katanga. The production of copper during the first ten months of 1919 has been 18,339 tons, and the estimated total for the complete year is 22,000 tons. Many adverse conditions have combined to prevent the output reaching the expected figure, 30,000 tons. The concentration plant to treat 4,000 tons of low-grade ore per day is expected to be ready for work this time next year. The test plant for leaching and electrolytic precipitation is under construction.

West Africa.—The output of gold during October was £91,352, as compared with £100,401 in September. The low figure is due to a strike at Ashanti Goldfields, owing to the disinclination of the workers to take paper currency instead of the silver to which they are accustomed. The output was £22,914, as compared with £36,102 in September.

The report of the Ashanti Goldfields Corporation for the year ended September 30 shows that 85,566 tons of ore was treated for an output of 97,717 oz. of gold, being a yield of 22·84 dwt. per ton. The figures for tonnage and output were 19,886 tons and 10,673 oz. respectively less than those of the previous year, the fall being due chiefly to the influenza epidemic during the latter part of 1918. On the other hand the yield per ton was 2·28 dwt. higher. The total income was £429,271, and the working profit £213,384. After deducting cost of development £20,701, royalty £20,903, and depreciation, etc., £19,363, there remained a net profit of £152,396. The dividends absorbed £165,458, being at the rate of 75%. The working cost per ton of ore was 59s. 4d., or 5s. per ton higher than during the previous year. Development has maintained the tonnage of reserve, but the grade is lower. On the deepest level, the 18th, the ore-body is much wider than above, the average being 34 ft., at two places the width being over 50 ft., but the assay-value is lower here than the average of the mine, being 19·8 dwt. as far as developed. The average content of the ore reserve is accordingly down by 1 dwt. per ton. On September 30 the reserve was 529,500 tons averaging 27·26 dwt. The Ayeinm and Justice's mines have not been worked during the year owing to the grade of their ore being too low for present costs. Mr. W. R. Feldtmann, the consulting engineer, reports that the main shaft requires repair, and that provision must be made to treat more ore in order to counteract the effect on the profits of the lower grade of the ore in the bottom levels. It is necessary also to provide additional suction gas engines, owing to the increasing difficulty of obtaining supplies of firewood for the steam plant. To provide funds for this expenditure, the directors are issuing the remaining shares, 146,943, of par value 4s. The price of issue will be 8s. per share, and the offer will be made first to shareholders. As the shares have stood in the market recently at from 22s. to 25s., the present issue will form an acceptable bonus to shareholders. The report states that the option on the Mamkwadi tin concessions extends until April 2, 1920.

Australasia.—The strikes at Broken Hill and Kalgoorlie continue, and the labour question is as difficult as ever. It is obvious that the loyal men returned from the war must be supported by the employers against the disaffected indifferents who have no inclination to duty towards their country or to the general community.

The Celebration Lease on Block 50, Hampton Plains, has been acquired by Messrs. Lionel Robinson, Clark & Co., and a company, to be known as Hampton Celebration (W.A.), Ltd., is being formed in London to work the property. The capital is to be £250,000. The purchase price is £50,000 in cash and £100,000 in shares; £25,000 in shares will be paid the promoters for guaranteeing the issue, and £75,000 will be available in cash as working capital. The directors will be Sir Newton Moore, William Clark, J. H. Cordner-James, W. W. Slater, and R. S. L. Harding. Cable messages state that the average assay-value of the ore in the shaft down to the 100 ft. level is £5. 10s. per ton. In the north and south drives along the east wall of the lode the ore averages 78s. for the length, 64 ft. In a cross-cut driven 9 ft. west from the face of the south drive the ore averages 67s., and in a similar cross-cut from the north drive it averages 63s., in both cases ore still showing in the face. Slavin & Evers' lease on Block 48 has been acquired in Adelaide, where it has been floated as the "White Hope."

The reconstructed Bullfinch Proprietary has secured four leases at Wombola on Hampton Plains, situated about ten miles south-east of the Celebration Lease, Block 50. The Hampton Uruguay Co., which owns Block 48 on which Slavin & Evers' Lily of the Valley lease is situated, has engaged Mr. C. S. Honman, lately Government Field Geologist, to make an inspection with a view to securing claims for the company. Mr. Honman states that he is not greatly impressed with the finds on Block 48 other than Slavin & Evers'.

The amount of ore smelted at Mount Lyell during the year ended September 30 was 176,569 tons, of which 116,375 tons came from the Mount Lyell mine and 60,194 tons from the North Lyell; in addition 7,890 tons of concentrate was smelted. The output of blister copper was 5,377 tons, containing 5,314 tons of fine copper, 266,864 oz. silver, and 5,538 oz. gold. The net profit was £130,232, of which £128,919 has been distributed as dividend, being at the rate of 10%. At the North Lyell mine, high-grade ore is still being developed on the 850 ft. level north, and on the 925 ft. level the results of drilling and development indicate the continuity of the ore. The reserve at Mount Lyell is 1,910,388 tons, and at North Lyell 960,242 tons.

India.—For the last year or two it has been known that developments at the Mysore mine had been yielding no great amount of better grade ore, and that the reserves of this quality of ore, particularly those in Tennant's section, had practically come to an end. The mine has in fact gradually changed its characteristics, and it may now be reckoned as a deep low-grade property. After over thirty years of remarkable prosperity, nearly nine million pounds having been distributed as dividend out of a total yield of nearly twenty million pounds, the mine becomes once more a prospect. It is proposed now to raise more capital by issuing 610,000 new shares at par, 10s., thus doubling the nominal capital of the company. With the funds thereby raised further shaft-sinking will be undertaken, and, in addition, lateral exploration will be conducted on a systematic scale. This policy has been rendered necessary largely by the serious curtailment of development during the years of the war. High temperatures, want of ventilation, and rock-bursts have also been hindrances. The engineers point out that the "mine has from time to time encountered zones of impoverishment which have in due course given place to high-grade ore. For some time past the deeper levels have shown a repetition of the variableness of quartz-reef mining and have been producing ore of lower grade, while the reef has been of less width than in the upper levels. These features have been particularly in evidence during a period when the prosecution of developments to a greater depth in the principal sections of the mine, and especially at Ribblesdale's, where the indications afford much hope that a new pay-shoot has been encountered, has been unavoidably retarded, thereby lessening for the time the possibilities of fresh discoveries being made."

Malaya.—The Malayan Tin Dredging Co. reports that the construction of two new dredges is being proceeded with. The capital necessary was obtained earlier in the year, when 59,000 shares were subscribed at £2. 3s. each. The output of tin concentrate during the year ended June 30 was 702 tons, obtained by four dredges, which treated 3,256,540 cu. yd. of ground. The yield per yard was just under ½ lb. The profit for the year was £40,497, out of which £33,200 has been distributed as dividend. Additional land covering 18 acres has been bought, making the total area 1,583 acres, of which 210 acres has been worked out.

The Pahang Consolidated, during the year ended July 31, milled 236,100 tons of ore, from which 1,815 tons of tin concentrate was extracted, against 187,300 tons and 1,993 tons the previous year. Advantage of the high price of tin was taken in order to work blocks of ore that would not otherwise be payable. The output of alluvial tin concentrate was 215 tons. The profits for the year were £68,414, as compared with £161,113 the year before. Willink's lode was cut on the 900 ft. level, and drives east and west have been commenced. The lode so far proved along 115 ft. averages 2½ to 3% over 5 ft.

British Guiana.—The official report of the

Land and Mines Department for 1918 shows that the output of gold was valued at £89,762, a fall of about £18,000 as compared with 1917. The royalty on gold won by dredging has been abolished, and a charge of 5% on the profits substituted. The output of diamonds, obtained by river washing, was 14,196 carats, estimated to be worth £29,575.

Cornwall.—The most important event in Cornwall during the past month was the public demonstration of the flotation process applied to tin ores. As mentioned by our Camborne correspondent a few months ago, the members of the engineering staff at East Pool, headed by Mr. M. T. Taylor, superintendent, and Mr. J. W. Partington, chemist, have lately devoted much time to research on this line. It is known that cassiterite is amenable to treatment by flotation, but the reagents hitherto tried have not secured satisfactory differential action between it and the gangue minerals. The experiments conducted by Minerals Separation on Cornish ores did not get sufficiently good results to make the process a commercial success. The East Pool engineers have found a reagent which secures an effective flotation of the cassiterite without bringing up the quartz and other gangue minerals. Their reagent floats the wolfram also and, of course, the sulphides. The concentrate is refloated to remove the sulphides, and the cassiterite and wolfram are separated magnetically. At the present time the output of one Holman stamp, 25 tons 30 mesh, is going direct to the flotation cells, where over 90% of the tin content is recovered. Our readers will no doubt canvas the question as to how the East Pool process stands towards Minerals Separation. The plant and process are of the agitation-froth type, and thus come presumably under the Minerals Separation master patent; the Taylor-Partington patent covers the use of a particular reagent for effecting a particular separation. While it is true that, theoretically, the flotation of cassiterite is no new thing, it is equally true that its effective commercial flotation is a distinct novelty.

United States.—The Garred-Cavers method of employing pulverized coal in blast furnaces has been adopted at the Garfield smelter of the American Smelting & Refining Co., and at the Midvale plant of the United States Smelting, Refining, & Mining Co. At the latter plant lead ores are being treated, and one-third of the coke is replaced successfully by pulverized coal.

Minerals Separation has brought an action against the Nevada Consolidated for infringement of patent, and is asking for a return of all gains and profits during the past four years over and above those that would have accrued from ordinary water-concentration. This company uses the Callow cell for flotation, and claims, as did the Miami, that this cell is not an infringement. The Miami suit never went to the Supreme Court, but there still is some intention of taking it there.

Spitsbergen.—The Northern Exploration Co., has published Mr. William Selkirk's conclusions with regard to the properties at Spitsbergen. Of the much advertised iron ore deposits at Recherche Bay he says: "I do not think they are of any economic importance." Thus is the great bubble burst!

Siberia.—The operating companies of the Urquhart group, namely, the Irtysh, Kyshtim, Tanalyk, and Russo-Canadian Corporations, are to be amalgamated into one big company, the Russo-Asiatic Consolidated, which will have a capital of £12,000,000. The shares to be immediately issued in exchange for present shares total £8,456,972, divided respectively among the four companies as follows: £3,442,838, £2,520,000, £725,982, and £1,768,152. Each shareholder in the first three companies will receive two new shares for every one now held, and those in the Russo-Canadian will receive one new share for each preference share and one-half of a new share for each common share. The new company will assume liability for the Irtysh and Tanalyk debentures and the Irtysh options. In assessing the value of the Irtysh, Kyshtim, and Tanalyk shares for exchange, the averages of the market quotations during the last five years have been taken. As regards the shares of the Russo-Canadian, the basis is the cash resources £830,000, and the share capital of the Prospecting Company, a Russian company owning extensive mining areas in the Steppes. The Russo-Canadian, it will be remembered, was formed when Sperling & Co. took a financial interest in the group, and besides raising capital, it had the function of holding the shares in the Russian companies owned by the three English operating companies, the object being to create a Canadian voting trust that would prevent Germans buying the control. This danger is now past, and finance can safely return to more normal lines. The present consolidation is a big one, probably the biggest on record in mining. The arrangement will certainly simplify the process of applying new capital to the various ventures, and it will strengthen the group in securing and maintaining its mining rights.

THE CHINA CLAY INDUSTRY OF THE WEST OF ENGLAND.

By HENRY F. COLLINS, A.R.S.M., Assoc.M.Inst.C.E., M.Inst.M.M.

(Continued from the November issue, page 275).

IN the first article, appearing in the November issue of the Magazine, I gave an account of the occurrence of china clay in the West of England and of the methods of mining. The present article is devoted to the purification of the clay and its preparation for market.

PURIFICATION.—Arrived at surface, the clay water passes in a wide shallow stream through several series of long narrow channels built either of wood or of masonry. A common size for each channel is 2 ft. wide by 9 in. deep by 20 ft. long; the number of channels in each series may vary from 6 up to 30, according to the volume of the clay stream to be dealt with. The number of series may vary from four to six. In the first series, called "drags," the stream runs with sufficient velocity to keep in suspension all but the fine sand. In the second and following series, called "micas," it is spread out over a greater area and allowed to run more sluggishly, with the result that it deposits the finest sand and the flakes of mica carried up to this point in suspension. Movable wooden slats or traps, actuated by a lever, act as dams to control the depth and velocity of the parallel streams in each series of channels, and so control the proportion and fineness of the sediment deposited. At intervals the flow of clay water is interrupted, and the sediment is scoured from the "micas" and run into separate pits, whence, after deposition of only the coarser particles in a separate series of "drags," the resulting product forms an inferior grade of clay called "mica-clay," or simply "mica." Fig. 6 shows a series of "mica-drags" or "micas" built of stone in the old-fashioned way. Fig. 7 is an end view of part of a long series of "micas" built of wood.

For the purpose of cleaning, each channel of the series is provided with a plug-hole opening into a launder, channel, or pipe, running crossways underneath, through which the deposited mica is run into its own separate pits.

The coarser part of the fine sand raised with the clay water is often separated in one or more spitzkasten before it passes to the first series

FIG. 6. OLD-FASHIONED "MICAS" BUILT OF STONE.
(Photo, English China Clays, Ltd., St. Austell).

of "drags." The bottom discharge from such spitzkasten may be either intermittent or continuous. In the latter case, provided the washing in the pit is sufficiently well regulated to yield a stream of nearly uniform composition, the product from the first series of "drags" (which is suitable only for brickmaking) may be comparatively small in amount, and a mica-clay of good quality, suitable for inferior grades of paper, &c., may be produced from nearly the whole series of "mica-drags." In other cases two sorts of mica-clay are produced, the inferior kind carrying some fine sand.

FIG. 7. PART OF A LONG RANGE OF "MICAS," BUILT OF WOOD (*Photo, English China Clays, Ltd., St Austell*)

FIG. 10 RANGE OF "DRYS," OR DRYING-KILNS, WITH RAILWAY SIDING (*Photo, English China Clays, Ltd., St Austell*)

At the head of the "micas," and frequently at the tail also, fine wire-cloth screens are employed to separate grass, fibres of timber, and

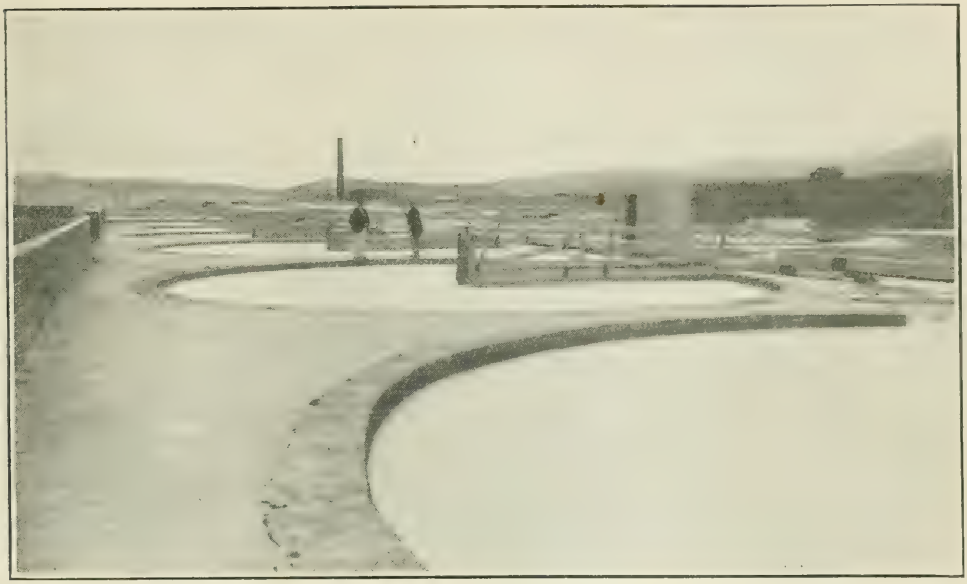


FIG. 8. ROW OF SETTLING PITS.
(Photo, English China Clays, Ltd., St. Austell).

other extraneous vegetable matter. These are in some cases revolving; in other cases fixed screens are employed, cleaned automatically by revolving brushes.

In order to completely settle out the mica flakes, the clay stream should not contain more than 3 to 4% solids, but as this is not an economical consistency for pumping it is best to use as little water as possible in washing, so as to pump a clay stream with 5 to 10% solids, and dilute with clean water at the head of the "micas."

SETTLING PITS.—The stream of purified clay water from the "micas" runs through wooden launders or earthenware pipes to the settling pits, partly dug out of the ground and partly built up. These are almost always circular, lined with masonry, from 25 to 40 ft. in diameter, and from 8 to 10 ft. deep. These were formerly lined with "drystone" granite masonry, built with moss in the joints instead of mortar, and backed with sand, but nowadays the masonry is more generally built with mortar, and the pits are often cement-lined. At the side opposite to the entrance of the clay water a narrow "hatch" or sluice-gate is fixed, towards which the whole floor of the pit slopes slightly; this is provided with plug-holes which are kept closed, except those near the top through which the clear water overflows. The pits are used for settlement intermittently, the stream being divided among such proportion of them as will allow of complete settlement of the clay before reaching the overflow plug-hole. When each pit becomes filled to within say a foot from the top with clay slurry of the consistency of clotted cream, and containing say 60 to 70% of water, the entering stream is shut off, the plank slide or gate is raised, and the whole contents of the pit are discharged, with a little help from long-handled wooden rabbles or "shivers," into rectangular storage tanks at a lower level and above that of the drying kilns. Fig. 8 shows a series of large circular settling pits.

STORAGE TANKS.—Like the pits, the "tanks" were in general formerly built of drystone granite masonry, backed with sand and mica-clay, and chinked with moss, the floor only being carefully paved with flat granite stones bedded in mortar. In most of the newer works, however, the tanks are lined with cement, and a few are roofed over to prevent contamination of the clay by dust and chimney smuts or other foreign matter carried by the wind. Their size varies in different works, but they run generally from 100 to 180 ft. long, by 40 to 60 ft. wide, and 6 to 9 ft. deep. Each tank is provided with a wide door or hatchway leading to the kiln, and closed with slats of heavy plank. In these tanks further settlement takes place, and a little more water is drawn off by means of plug-holes. Finally, upon removal of the top slats of the hatch, some of the thick slurry nearest to it can be run directly into the "dry," while the bulk of it is loaded into wooden waggons on movable sections of tramway, which are run

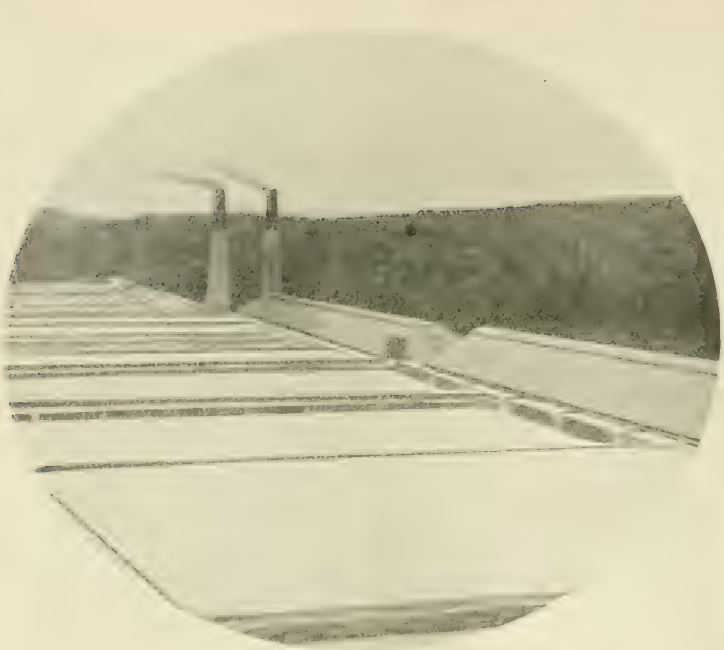


FIG. 9. ROW OF STORAGE TANKS
Photo. English China Clays, Ltd., St. Austell

through the door or hatch on to a "traveller" or travelling bridge. This is a four-wheeled platform or truck, carried at each side of the "pan" by longitudinal rails upon which its four wheels run, and it is worked up and down the "dry" either by a small motor, or more frequently by hand, so as to facilitate even distribution of the clay over the whole area of the pan, the distribution being completed by means of wooden "shivers."

Fig. 9 shows a row of storage tanks full of clay behind a "dry." Where, as in this case, the configuration of the ground is suitable for building the tanks high above the level of the "dry," the wet clay is delivered from the tanks to the pan by means of inclined launders or shoots, which saves at least part of the tramming.

DRYING KILNS.—These are long roofed sheds, situated in front of the storage tanks, and with frontage either to railway sidings or to a road, the former being obviously preferable. Longitudinally they are divided into two parts, one being the "pan" or drying-kiln proper, and the other, at a lower level, the "linhay" or storage shed.

Fig. 10 gives a general view of a long line of drying-kilns with railway sidings, and Fig. 11 shows a tank full of clay being trammed into the "dry."

The floor or "pan" of the "dry" is from 200 to 350 ft. long, and from 12 to 18 ft. wide. The extra length was designed with the object of economizing fuel, but this end is best served by attending to the combustion, as will be seen later. In modern practice, "drys" of only 200 to 250 ft. long give the best results; as to width, 15 ft. takes a little more labour than 12 ft., but provides greater drying capacity for a given outlay; 18 ft. has proved too wide for convenience in handling.

The "pan" is formed of fire-clay tiles about 12 in. long by 18 in. wide; they vary in thickness from 4½ or 5 in. at the furnace end to 2 in. or 2½ in. at the stack end, and are made either with a plain-cheeked or a tongue-and-groove joint. They rest upon thin walls of firebrick, 4½ in. wide, forming the flues, which are usually 14 in. wide, and decrease in depth from 18 in. at the furnace end to 9 in. at the stack. The furnaces for kilns of 14 and 15 ft. wide are usually three in number, each feeding either three or four flues according to the width of the "pan"; they burn ordinary long-flame coal, and nowadays are provided with doors to the ashpits for better control of the draught, which is provided by a chimney stack from 50 to 150 ft. high. The wet clay is spread upon the floor in a layer varying from 10 to 12 in. thick at the fire end, down to 5 or 7 in. thick at the stack end; in drying, the clay shrinks down to thicknesses of about 9 in. and 4½ in. respectively. At the hot end the clay dries out in 24 hours, while at the other end it takes at least 3 or 4 days; in the very long kilns 6 or 7 days. When about half dry the mass of clay is scored part way through by means of a heavy sharp-edged hook or "cutter," to prevent it from cracking into irregular blocks, and in order to form rectangular ones about 12 in. by 6 in., by 5 in. to 9 in thick. These, when dry, are thrown off the "pan" by hand, and stacked in the "linhay" at the side, from which they are loaded by hand and shovel, either into railway trucks, or into 3-ton four-wheeled road waggons if transport is by road. The fuel consumption for drying clay ranges from 8 to 14%; an average would be 10 to 11%.

Fig. 12 shows the pan of one of the drys, with bed of half-dried clay upon it, which has just been scored into rectangular blocks by the "cutter." Fig. 13 shows clay being loaded from the "linhays" into railway trucks.

PIPING TO DRYS.—The deposits of clay are situated upon the moors within the limits of the granitic outcrops, and at a distance usually of many miles from the nearest seaport; sometimes, though nowadays not often, they are miles away from even a railway siding. At most modern clay undertakings, therefore, the drying of the clay is effected close to the shipping port, or to a convenient railway siding, in order to save both the uphill haulage of coal and the much more considerable downward transport of the clay itself by road. The purified and thickened clay pulp is carried from the works to the "dry" (always downhill), in a pipe-line of ordinary 8 in. to 10 in. stoneware drainpipes with cement joints, the grade being kept as regular as the configuration of the ground will admit. In order to avoid choking and settlement of clay at specially low joints where the flow is checked, the pulp is thickened to a solid content of only 12 to 20%, and the pipe is not run more than half full, except at occasional syphons over streams, &c. Under these conditions, with a fall of not less than 1 ft. in 100 and care being taken to flush out the pipe with clean water at night, or whenever from any cause the stream of pulp is temporarily stopped, no difficulty is experienced with choking, even in pipe-lines of five or six miles in length. At the lower end of the pipe-line the stream runs into large rectangular tanks, which serve for both settling and storage, and frequently hold from 1,000 to 2,000 tons apiece; the handling and drying of the clay is then effected as usual.

In order to thicken the clay stream from a content of $3\frac{1}{2}$ or 4% solids, which gives the best result in the "micas," up to the 12 to 20% solid contents required for the pipes, and with the object of conserving water (often scarce) for use over again in washing, the purified pulp from the "micas" has to be thickened for transport. This is best effected in conical pits, 30 to 40 ft. diameter at the top, the sides being vertical for say $2\frac{1}{2}$ ft. and thence deepening to 15 ft. at the centre, where a valve of the conical-plug type is fixed, discharging into a tunnel below the pit. By means of this pit and valve the constant discharge can be controlled so as to carry any desired percentage of solids. Fig. 14 shows a range of conical bottom-discharge settling pits employed for thickening clay pulp for continuous delivery to the pipe-line. At some works it is preferred to use an ordinary type of circular or rectangular pit with discharge at one side. In such cases discharge is effected intermittently, each pit being allowed to fill in succession, as in the ordinary way of working when pits are close to the storage tanks of the "dry," and the contents are then flushed out into the transporting pipe-line with the aid of a small stream of water under pressure from a 1 in. or $\frac{3}{4}$ in. nozzle.

RECENT IMPROVEMENTS. *(1) Filter-Presses.*—At several works filter-presses have been tried for reducing the quantity of water to be expelled in the kilns, and, therefore, the fuel consumption, which, with coal at from £2 to 50s. per ton, is a serious item of cost. At its ordinary consistency for transfer by means of waggons from the tanks to the "dry," the clay slurry contains at least 50% of water, and often more. By means of Johnson filter-presses, filled by pumps working at 90 lb. pressure, the proportion of water in the cakes can be reduced to about one-half of this, with a nearly corresponding saving in the theoretical fuel consumption for drying. The presses have 46 leaves 4 ft. square and take a charge equal to 30 cwt. of dry clay, which is turned out in cakes $1\frac{1}{2}$ in. thick. Each completed operation takes half an hour, so that the output of two presses worked alternately by two men upon 8-hour

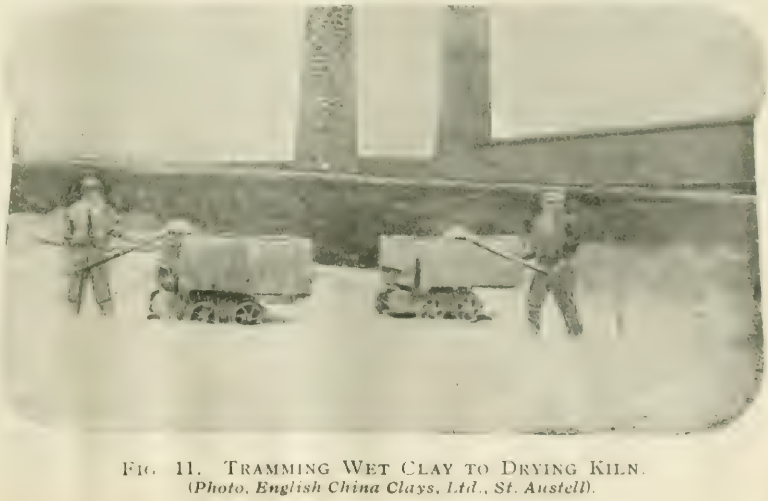


FIG. 11. TRAMMING WET CLAY TO DRYING KILN.
(Photo. English China Clays, Ltd., St. Austell).

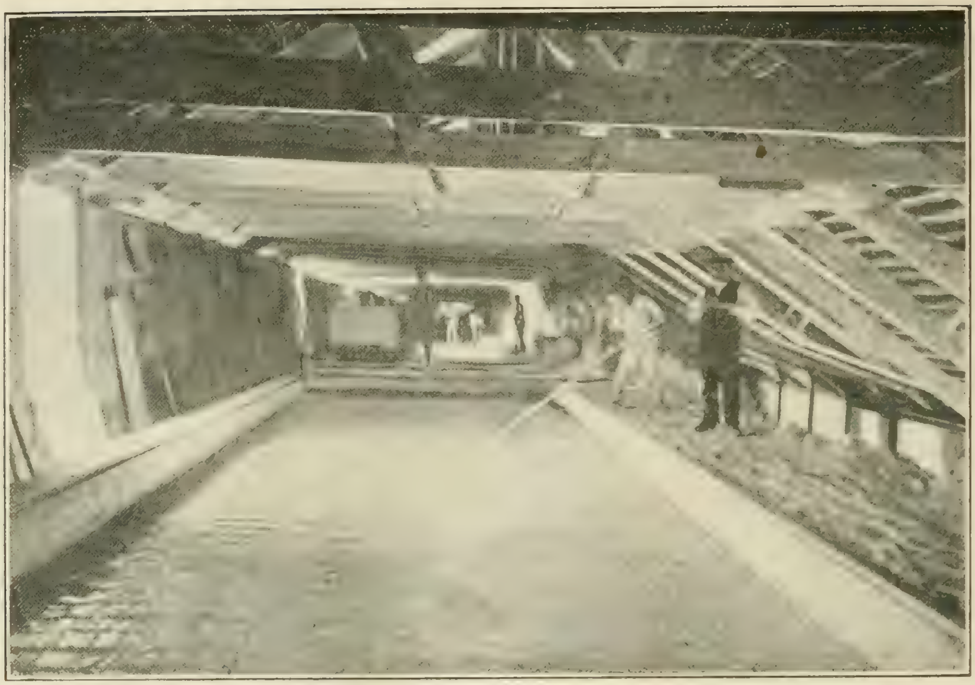


FIG. 12. CLAY KILN, SHOWING SCORING INTO RECTANGULAR BLOCKS.
(Photo, English China Clays, Ltd., St. Austell).

shifts (6 men altogether) is about 400 tons per week. The slurry for delivery to the presses has to be diluted from 50% to 80% water for handling by the pumps. Difficulty was experienced in handling and drying the cakes as they leave the press; this has been overcome by feeding into a horizontal pug-mill which turns out wire-cut blocks 12 in. by 9 in. section and 10 in. long, weighing about 80 lb. when dry; these are loaded upon a tipping tray carried upon an electrically-driven traveller for distribution upon the "pan" of the "dry." The fuel economy is not so great as might be expected from the reduced percentage of water in the clay, on account of the low heat conductivity of the material, and because some heat appears to be lost up the cracks between the blocks. The labour cost is greater than for the ordinary drying process, and the extra cost of this, together with that of fuel for the pumps, and wear and tear of presses, replacement of cloths, etc., goes far to offset the saving of fuel in drying.

Drying.—Great economy of fuel in the drying operation has been recently effected by the West of England Company (now English China Clays, Ltd.) through attention to the proper combustion of the fuel, and elimination of all excess draught of cold air through the furnaces. The result of much careful experimenting, with analyses of the flue gases, showed that the greatest source of avoidable loss of heat in the drying operation consisted in the passage through the furnace of a volume of air far in excess of that required to effect perfect combustion of the fuel consumed. A second source of loss, especially after firing up, was attributable to imperfect combustion of the fuel, and escape of CO from the furnace before it had time to burn to CO_2. Accordingly, the ash-pits are now kept permanently closed (except for cleaning), pans of water are kept below in order to generate some steam, and the only air supplied under the grate is preheated by passage through auxiliary flues in the brickwork, while currents of secondary air, also pre-heated, are supplied through appropriate holes in the crown of the furnace arch, in order to burn CO just over the bridge. Slide dampers are placed in every air current, and draught and temperature indicators in the flue at the base of the stack make records hourly. The results are controlled, not only by these, but by automatic CO_2 recorders at the base of the stack, which analyse the waste gases and record the percentage of CO_2 in them every ten minutes. By these various means perfect combustion of the fuel is assured, with a total supply of air not more than double that theoretically required. The heat is carried much farther down the flues, so that the hot part of the " pan," upon which a charge of clay can be finished and renewed every 24 hours, is extended down the " dry " to nearly double its former length, and the volume and the temperature of the waste gases passing up the chimney are both reduced to about one-half. The net result is to diminish the fuel consumption by between 30 and 50% according to whether the previous practice in the "dry" was fairly good or bad.

At several works aluminium sheets $\frac{1}{4}$ in. thick have been substituted for the 2 in. fire-tiles at the stack end of the long drying kilns. Being good conductors, the small amount of available heat in these gases is more readily transmitted to the clay on the " pan " through these sheets than through the tiles, with the result that, instead of taking 5 to 7 days to dry out with tiles, the clay at the far end, with these sheets, can be dried in 3 days. The cost of the aluminium sheets is of course heavy, and figures are as yet lacking as regards their durability and wear and tear, but the economy in fuel and somewhat increased output of clay are thought by some to justify the experiment. Better results, however, in the very long kilns (300 to 350 ft.) are likely to result from cutting them into two, erecting a short stack near the centre instead of a high one at one end, and providing furnaces at both ends, the combustion in which is properly controlled, following the practice at the West of England kilns at Nanpean, where several of the very large drys have been cut down in the manner described.

Settling.—Instead of settling out first the fine sands and " mica " in the usual channels, and then settling the clay in pits, an attempt has been made to separate both at the same time by centrifugal force in cylindrical containers, into which the clay stream is introduced at the top. Sand and mica settle first, near the top of the vessel, while the clay settles near the bottom, where the effluent clear water is thrown off. Up to the present time no commercial success has attended this method.

Electrolytic Purification. — It has been proposed to improve the colour of clay discoloured from the presence of iron oxide by passing a continuous current of electricity at from 60 to 100 volts through the slowly moving stream of clay slip passing sideways through a trough of semi-cylindrical section. The anode consists of a metallic drum revolving slowly within the trough, while the cathode is a half-cylinder of wire netting suspended within it, concentrically with the anode, and only half an inch away from it. The clay stream, charged with some mineral electrolyte, flows slowly between the electrodes. The principal harmful impurities, oxides of iron and titanium, being electro-positive, pass through the wire netting, and collect underneath it, whence they are removed by means of a continuous worm discharge, while the purified clay, being electro-negative, attaches itself to the drum, from the top of which a fixed knife removes it in the form of a coherent slab about half an inch thick. The process, designed originally for the purification of Continental clays of inferior quality in order to fit them for the manufacture of high-tension insulators, does not appear to be required for best English china-clays, which are purer without such treatment than the Continental clays referred to after treatment. It has been suggested that the colour of inferior Cornish china-clays could be so

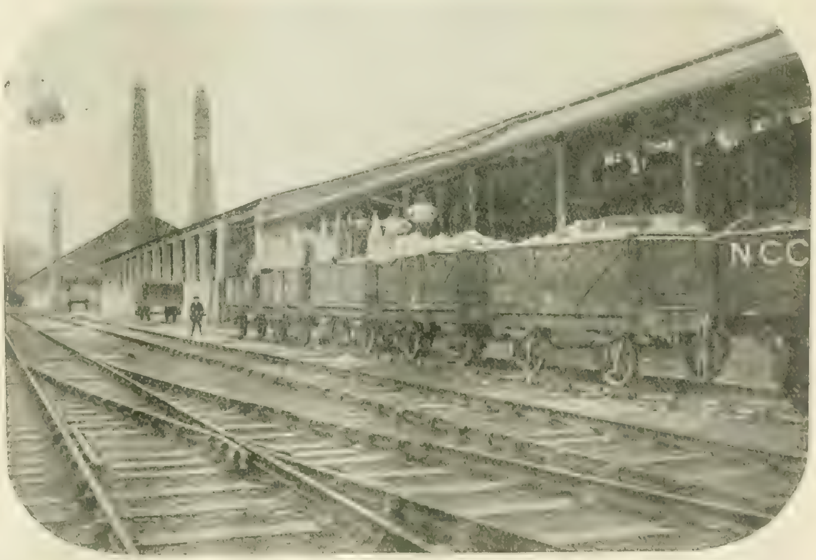


FIG. 13. LOADING CLAY FROM "LINHAYS" INTO RAILWAY TRUCKS.
(*Photo, English China Clays, Ltd., St. Austell*).

much improved by electrolytic treatment of similar nature, as to enable them to be graded as of much higher quality. So far, however, it does not appear that the improvement effected in the quality of the clay and its selling price is likely to be sufficient to compensate for the heavy extra cost.

FIG. 14. CONICAL BOTTOM-DISCHARGE SETTLING PITS, THICKENING PURIFIED CLAY PULP FOR THE PIPE-LINE.
(*Photo, English China Clays, Ltd., St Austell*)

CLASSIFICATION OF CLAYS.—In the trade, china-clays are roughly divided into two classes, "potting" and "bleaching"; in each category three grades are recognized, "best," "medium," and "common," based mainly on the colour, the best clay being of course the whitest, and the common generally speaking the yellowest. The proportion of the pre-war output of china-clay recognized as of "best" quality was not more than 15% of the total, more than one-half of the total output being classed as "medium," for which reason that grade was again informally sub-divided into "good medium," "medium," and "low medium."

The yellow colour of common clays in their condition is generally due to iron oxide. Such is, however, by no means invariably the case, and a yellowish tinge (particularly in clays graded as medium) frequently arises wholly or in part from some form of peaty or organic matter, which upon burning disappears, leaving the clay dead white. In such cases the slight tinge of colour in the raw clay is no detriment when it is intended for "potting." To some extent potting clays may be used indiscriminately for bleaching, and vice versa; this is largely the case in foreign markets, particularly in the United States. As regards the home trade, however, the distinction is nevertheless real enough, particularly as regards "best clays," although the reasons for such a distinction between the two classes are often obscure. Chemical analysis shows that but little difference often exists in their ultimate composition between many "best potting" and "best bleaching" clays. In general it may perhaps be said that most of the "best potting" clays average 1 or $1\frac{1}{2}\%$ higher in silica and lower in alumina, while the percentages of lime and alkalies may be a little higher, although in any case low. There is, however, no absolute guide as to the "potting" quality of clays to be derived from chemical analysis, for the clays numbered 4 and 5 in the list of analyses already quoted, which represent the two extremes of composition amongst British china-clays, happen to be both "potting" clays, although used by different potting firms, doubtless in combination with very different proportions of other ingredients. Potting clays in their raw condition are, speaking generally, somewhat less dead-white than the more highly esteemed of the bleaching clays, although they must "fire" white. When dry they are often more powdery, and when wet often become more plastic, although by no means invariably so. Speaking generally, it may be said that good potting clays are found nearest to the unaltered granite, and are associated with a certain amount of unaltered orthoclase felspar. The possibility is suggested that the greater suitability of such clays for that particular purpose may arise either from a slight lack of completeness in the decomposition of the orthoclase felspar, or in an originally somewhat greater proportion of plagioclase, indicated by a slightly higher percentage of alkalies and alkaline earths in the clay. Possibly it may be due in part to an average coarser grain of the particles, reflected in a general, though by no means invariable, greater rapidity of settling. It is noteworthy that some of the highest grades of bleaching clay appeár to settle very slowly, and the slurry, when of a given degree of viscosity, contains in fact a higher percentage of water than that found in other china-clays when of the same consistency, so that more fuel and more time is consumed in drying. This may be due either to an average smaller size of the individual particles of the clay, or to some difference in their surface condition, and their affinity for water.

(*To be continued*).

THE MINERALS OF ANATOLIA

By NORMAN M. PENZER, B.A., F.G.S.

The author gives particulars of the mineral deposits of parts of Asiatic Turkey, about which little is known in this country, though the Germans compiled records some years ago.

(Concluded from November issue, page 283.)

MINING LAWS.—The Turkish mining laws have formed one of the many obstacles put in the way of the prospective miner in Anatolia. From time to time the laws have been revised, but have only undergone trifling alterations, and have always presented numerous complications and endless trouble in obtaining concessions. The most recent mining law is dated March 26, 1906, and applies alike to Ottoman subjects and foreigners. The law was revised in 1913, but nothing of importance was added.

The application for a concession passes through the hands of the "Vali," the "Mutessarif," the "Caimacan," and finally of the "Nadir" of the "Nahie" where the mine is actually situated. The Nadir consults the Council of the district, and the application then goes slowly back to where it started, and then to the Administrative Council of the Vilayet. The Council examines specimens of the ore of the mine for which the concession is required, listens to what opponents have to say, and finally submits the concession for the approval of the Minister. Even this is not the end of it, for the Minister passes it to the State Council, then to the Council of Ministers, and lastly it is submitted for Imperial sanction.

It is superfluous to say that the question of baksheesh plays a large part in the transactions, especially in the "Nahie" where the mine is situated.

The Local Council, as soon as they are consulted about a concession, begin to imagine that there is great wealth hidden underground which they should naturally keep to themselves. Other inhabitants get up a systematic opposition, and it is here that the use of well-distributed baksheesh is of the greatest assistance.

The Foreign Office Report on the mining industries in Turkey, mentioned in the bibliography, states that the discoverer of a mine or deposit obtains a prospecting licence, available for a period of two years. Should his further workings during this period give satisfactory results, he applies for a "Firman," or Imperial concession, which is only accorded after inquiries and formalities of a more or less lengthy duration, depending chiefly upon the reputed value of the mine, and the ability of the applicant to influence the decision of the authorities in whose hands the matter lies. Once a firman conceding a mine has been obtained, the rights acquired are transferable to the concessionaire's heirs, as well as to private individuals or to companies. The latter have to submit, like all holders of real property in Turkey, to Ottoman law. Transfers of mining concessions are only made at the Ministry of Mines and Forests; no other deed is valid.

The lands comprised within the limits of the concession are subject to a fixed annual payment, calculated on the area of land covered by the firman.

The minerals actually exported have to pay a proportional tax (royalty) varying from 5 to 20%, calculated upon the price fixed by the concession. A customs duty of 1% ad valorem is also levied.

In the case of minerals, of which the price fluctuates according to the output, a bill of sale, legalized by the Ottoman Consul at the port of discharge, has to be procured by the concessionaire and presented to the Mining Department after delivery of the exported quantity. The selling price of most minerals is agreed upon on the basis of given terms which vary according to their nature. The shipper usually provided 75% of the total value against bill of lading and insurance policy.

Besides the taxes above mentioned, the State often reserves for itself the right of a third of the net receipts in the terms of the concession or interests on the disbursement of a fixed sum, or a certain percentage of the receipts for the Treasury coffers for the Municipality or the poor.

It has been suggested that it is more economical to ask for several concessions at the same time, in order to avoid useless and repeated expense.

It is not appropriate to enter into full details of the mining laws here, as, owing to the present state of affairs, there will have to be new mining laws made by the different nations taking responsibility for the future of the Turkish Empire.

RAILWAYS.—The following details regarding the railways of Asia Minor may be taken as being correct up to July of this year. Portions of one of the most important systems come far outside the country which has been treated from a mineralogical point of view, and extend as far as Baghdad. There are (exclusive of the Syrian Railways) 2,444 miles of line in Asiatic Turkey, which are divided as follows:

	Miles
(1) The Anatolian Railway	
Haidar Pasha to Angora.	358
Eski-shehr to Konia.	283
Hamidie to Adabazar.	10
(2) The Smyrna-Aidin Railway	
Smyrna to Egerdir.	
Smyrna to Budja.	
Kasimir to Sevdi Keui.	
Torbali to Odemish and Tire.	320
Balachik to Sokia	
Gonjeli to Denizli.	
Sutledj to Chivril.	
(3) Baghdad Railway:	
Konia via Adana and Aleppo to Nisibin.	650
Baghdad to Qalat Shergat.	187
Baghdad to Quraitu.	126½
(4) Chemin de Fer Smyrna-Cassaba et Prolongement:	
Smyrna to Afium Karahissar.	263½
Magnesia to Panderma.	176¼
Smyrna to Burnabad.	3½
(5) The Mersina, Tarsus & Adana Railway.	42
(6) The Mudania–Brusa Railway.	25
Total	2,444

Of the above railways, without counting those built during the war, and in 1914, 31% were controlled by the Turkish Government, 36·8% by the Germans, 0·7% by the French, and 10·5% by the English.

Konia, which is the beginning of the Baghdad Railway, can be said to be the dividing point of the railways now under allied military control. The railways west of Konia, including the Smyrna system (both the Aidin and Cassaba lines), are under the general control of the Inter-Allied Commission which has its headquarters at Constantinople, and a branch sitting at Smyrna. The control officers of these lines are all British, but they work under the authority of the Inter-Allied Commission. In the case of the Smyrna-Aidin railway the line is absolutely British, and has its head office in London. The railways east of

Map Showing the Railways of Asia Minor.

Konia are administered by the British under the authority of the G.O.C. Egypt, by means of the branch sitting at Aleppo.

The following notes on the different railways may be of interest.

(1) The Anatolian Railway.—The Ismid-Angora concession was granted by the Turks to one Kualla, Director of the Württembergische Vereins Bank of Stuttgart on behalf of the Deutsche Bank. This concession provided for the purchase of the Haidar Pasha-Ismid line. Construction was completed on December 31, 1892. This was the beginning of the original scheme for the Baghdad railway, which was later abandoned. In order to convey the coal from the Heraclean basin a branch line was started from Adabazar to Boli, and the Germans started building from Zunguldak towards Boli.

Beyond Angora an extension toward Yuzgat was begun in 1914. The line was to be built as a 4 ft. $8\frac{1}{2}$ in. gauge railway, but no rails for this gauge being available a Decauville has been laid down. This is complete for 45 miles close to the Kizil Irmak river. Embankments, culverts, etc., are complete for 125 miles, from whence onwards nothing has been done. The ultimate aim is to link up Angora with Sivas and Erzeroum. The company was, of course, in reality German. After the Baghdad route via Angora was abandoned, the line to Baghdad from Eskishehr to Konia was built.

(2) The Smyrna-Aidin Railway.—This is the oldest railway in Anatolia. The original concession was granted to a British group in 1856. In 1888 the concession was extended on condition that on its expiration the Turkish Government might buy out the company. In 1914 this agreement was cancelled for a new one, and the various concessions of the company were consolidated. The renewed concession expires in 1999. Just prior to the war the proposed extensions of this railway were as follows:

(a) Aidin to Marmarice, via Mughla.
(b) Afium Karahissar to Adalia, via Sandukli, Dineir, and Buldur.
(c) A line joining the lakes of Egerdir and Beyshehr.

(3) Baghdad Railway.—Although the Baghdad railway is often considered as starting at the Bosphorus, its true starting-point is Konia. The concession for the railway was granted in 1889 to the Anatolian Railway Company in the first instance, but was transferred to the Société Imperiale Ottomane du Chemin de Fer de Bagdad. This latter company was, like the former, under the control of the Deutsche Bank. The concession included a clause which gave the right to the company to work all mines found within 20 miles of the line. The war naturally proved disastrous to the railway. The branch line from Toprak Kale to Alexandretta was dismantled by the

Turks during the war, and various sections in the Taurus Mountains were incomplete. The line is now complete as far as Nisibin, which lies between Mosul and Diarbekr. Starting now from Baghdad the line runs north past Samarra to Qalat-Shergat. These two sections, therefore, form the Baghdad railway. There is a branch line from Baghdad to Quraitu on the Persian frontier. Other branches were built by the British during the war, and are being dismantled. A through metre-gauge line is being constructed from Basra to Baghdad.

(4) CHEMIN DE FER SMYRNA-CASSABA ET PROLONGEMENT.—This railway was leased to a Franco-Belgian syndicate in 1893, the British concessionaires who obtained the original concession in 1863 being bought out. The company was authorized to extend the main line from Alashehr to Afium Karahissar. The Soma-Panderma branch was opened in 1912. Among the proposed new branches may be mentioned Ushak to Gediz, and Balikesri to the mines near Balia.

(5) THE MESSINA, TARSUS, AND ADANA RAILWAY.—The concession for this line was granted in 1883 to a Turkish company, and after being under British and French control, passed in 1906 into the hands of the Deutsche Bank. As the object of the Deutsche Bank was to secure an outlet to the sea for the Baghdad railway, it obtained by degrees five-sixths of the share capital.

(6) THE MUDANIA-BRUSA RAILWAY.—The concession for this line was granted in 1891 to a Franco-Belgian group for 99 years. Various proposals of extension have been made, but German opposition proved too strong. The line is narrow gauge.

In 1913–14, concessions were granted to an Italian group for the building of railways with centres at Makri and Adalia. All developments have of course been held up.

In addition to the proposed extensions already mentioned are the following:

1. Chanak (on the Dardanelles) to Smyrna.
2. Angora-Yuzgat-Sivas-Erzeroum.
3. Samsun-Sivas.
4. Sivas-Kharput-Mardin.
5. Ada Bazar-Boli-Kavsa.
6. Yuzgat-Kaisariya.

BIBLIOGRAPHY.

The following bibliography on Asia Minor, although far from complete, contains under various headings the chief works and articles for about the last eighty years. With regard to the "geology" section, references are only given from 1900 onward, but two or three important works of earlier date will be found in the "general" section. It is obvious from this bibliography what a minute percentage of the works and articles published are English, and the huge percentage German. There is not a single comprehensive English article, let alone a book, on the mineral wealth or geology of Asia Minor. In recent years Dr. Oswald has written some very useful books on the geology of Armenia. It would be a great work if he would cover the whole of the late Turkish Empire. In France there are only about two good books dealing with the minerals in any length, those by Cuinet (1892) and Verney & Dambmann (1900).

The bibliography is divided up as follows: (1), General Works; (2), Geology; (3), Coal; (4), Meerschaum; (5), Miscellaneous.

I. GENERAL WORKS.

1842. HAMILTON. Researches in Asia Minor. London.

1867 (?). TCHIHATCHEFF. Géologie de l'Asie Mineure. Morgand, Paris. 3 vols. 8 vo. with coloured map.

1876. BITTNER (A), NEUMAYR (M), TELLER (F) Geologische Arbeiten in Orient.

1877. BURNABY (F). On Horseback through Asia Minor

1878. GEARY (G). Through Asiatic Turkey. London.

1885. GEORGIADÈS. Smyrna et l'Asie Mineure. Paris.

1886. HEYD. Historie du Commerce du Levant au Moyen Age. Furcy-Reynaud. Paris.

1887. BRACHET (D). Mémoire sur une Mission faite en 1884 pour l'Étude des Eaux Minérales de la Turquie. Paris.

1890. RAMSAY (SIR W. M.). The Historical Geography of Asia Minor.

1892. B[illegible]ARD. Rapport sur l'Egypte et sur la Turquie. Lyons.

1892. DERNBURG (F). Auf Deutscher Bahn in Klein Asien. Berlin.

1892, et seq. FOREIGN OFFICE. Consular Reports.

1892. ROUGON. Smyrna. Paris.

1892. KAERGER (K). Klein Asien, ein Deutsches Kolonizationsfeld. Berlin.

1894. BAUDIN. Abd-ul-Hamid II, et les Progrès de la Turquie. Paris.

1894. COURAU. La Locomotive en Turquie d'Asie. Paris.

1895. CUINET (V). La Turquie d'Asie. Paris.

1896. GOLTZ (C. Von der). Anatolische Ausflünge, Reisebilder. Berlin.

1896. NAUMANN (E). Die Grundlinien Anatoliens. *Geogr. Zeitschrift d'Hettner*.

1896. TOULA (F). Ueber die Auffindung einer Muschelkalkfauna am Golfe von Ismid, *N.J.f.Min.*, 1, p. 149, 2, p. 137; ibid, *Beitr. Paläont. Oesterr-Ung.* x., p. 153-191.

1897. RAMSAY (SIR W. M.). Impressions of Turkey. London.

1898. TOULA (F). Eine Geologische Reise nach Kleinasien, mit Beiträgen von E. Kayser und A. Rosiwal. *Beitr. Pal. Oest-Ung.*

1899. TOULA (F). Eine Geologische Reise nach

Kleinasien, *N.J.f.Min.*, 1, pp. 63-70.
1900. VERNEY (N) et. Les Puissances Étrangères dans le Levant, en Syrie, et en Palestine. Paris and Lyons.
1900, et seq. { Mensuel de la Chambre de Commerce Française de Constantinople. Constantinople. Mensuel de la Chambre de Commerce Française de Smyrna. Smyrna.
1903. FOREIGN OFFICE REPORT. Mining Industries and Forestry in Turkey. Miscell. Series, No. 589, May, 1903.
1908. NETTANCOURT-VAUBECOURT (J. de). Les Grandes Routes de l'Asie Mineure. Leroux, Paris.
1911. PEARS (SIR EDWIN). Turkey and its People. London.
1911. PECH (E). Manuel des Sociétés Anonymes Fonctionnant en Turquie. 5th edit. Constantinople.
1911. GARNETT (L. M.). Turkey of the Ottomans.
1911. FERRIMAN (Z. D.) Turkey and the Turks.
1912-13. Journal of the British Chamber of Commerce at Constantinople.
1913. MILLER (W). The Ottoman Empire, 1801-1913. Cambridge Hist. Series.
1913. ILITCH (A). Le Chemin de Fer de Bagdad. Riviere, Paris.
1914. BROWN (P. M.). Foreigners in Turkey. Juridical Status. Princeton.
1914. SCHMIDT (H). Das Eisenbahnwesen in der Asiatischen Türkei. Berlin.
1915. SYKES (SIR M.). A Short History of the Turkish Empire. The Caliph's Last Heritage.
1915. PHILIPPSON (A). Reisen und Forschungen im Westlichen Kleinasien. (5 parts). Gotha, 1915.
1915. LENCHARD (R). Paphlagonia; Reisen und Forschungen im Nordlichen Kleinasien. Berlin.
1916. WOODS (H. C.). Communications in Asiatic Turkey. *Field*, Mar. 25, 1916. pp. 482 4.
1916. MAUFERTHIUS (S). Voies Ferrées Asie Mineure et le Bagdad Bahn. *Science et Vie*, Mar. 1916. pp. 325-36.
1916. CHILDS (W. J.). Along the Black Sea Coast of Asia Minor. *Blackwood's Mag.*, April 1916. pp. 468-80.
1917. CHILDS (W. J.). Across Asia Minor on Foot. London.
1917. RAMSAY (SIR W. M.). The Intermixture of Races in Asia Minor. *Proc. Brit. Acad.* Vol. 7.
1917. WOODS (H. C.). The Baghdad Railway and its Tributaries. *Journal R. Geog. Soc.*, July 1917.
1917-18. *La Revue de Turquie*. Lausanne, 1917.
1918. HAWLEY (W. A.). Asia Minor.
1919. MONEY (R. I.). The Irrigation of the Konia Plain. *Jour. R. Geog. Soc.*, Nov., p. 298.

II. GEOLOGY.

1900. SCHAFFER (F. X.). Geologische Studien im Südöstlichen Kleinasien. Sitz. K. Akad. Wissensch., Wien, cix., pp. 498-525.
1901. SCHAFFER (F. X.). Zur Geotektonik des Südöstlichen Anatolien. *Peterm. Mitth.*, xlvii., pp. 132-137 (map).
1901. SCHAFFER (F. X.). Geologische Studien im Südöstlichen Kleinasien und in Nordsyrien. Anz K. Akad. Wissensch., Wien, cx., pp. 5-18, figs. and map.
1901. SCHAFFER (F. X.). Neue Geologische Studien im Südöstlichen Kleinasien. Sitz. K. Akad. Wissensch., Wien, cx., pp. 388-402.
1905. BUKOWSKI (G. V.). Ueber die Tertiärablagerungen von Davas in Kleinasien. Anz. K. Akad. Wissensch., Wien, 1905, pp. 52-55.
1906. TOULA (F). Zusammenstellung der Neuesten Geologischen Literatur uber die Balkan-halbinsel mit Morea, die Griechischen Inseln, Ægypten, und Vorderasien. *Jahresb. naturw. Orientver.*, Wein, xi., pp. 37-79, 1906.
1907. PHILIPPSON (A). Ein Gletscher am Erdschias-Dagh (Argaeus) in Kleinasien. *Zeitschr. f. Gletscherk.*, Berlin, i., pp. 66-68.
1909. KESSIER (P). Zum Geologischen Aufbau der Bithynischen Halbinsel. *Centralbl. f. Min.*, 1909, pp. 653-659.
1910. ENDRISS (W). Quer durch die Bithynische Halbinsel. *Peterm. Mitth.*, lxi., pt. 2, pp. 177-181, 236-240; pts. xxxi-xxxii. (map); and lx-lxi.
1910. PHILIPPSON (A). Reisen und Forschungen im Westlichen Kleinasien. *Peterm. Mitth. Ergänzungsh.*, No. 167, pp. i-iv., 1-104, pls. i-viii. and 1 geol. map.
1911. „ No. 172, pp. 1-100, pls. i-ix. and geol. map.
1911. FORBES (W. T. M.). A Geological Ride through Central Asia Minor. *Journ. Geol.*, Chicago, xix., pp. 61-82, figs. and map.
1911. BERG (G). Geologische Beobachtungen in Kleinasien. *Zeitschr. Deutsch. Geol. Gesellsch.*, lxii., *Aufsatze*, pp. 462-515, figs. and maps.
1912. PHILIPPSON (A). Die Neogenbecken Kleinasiens. *Monstab. Deutsch. Geol. Gesellsch.*, 1912, pp. 250-254.

III. COAL.

1852. SCHLEHAN. Versuch einer Geognost. Beschr. der Gerend zwischen Amasry und Tyrla-Asy an der Nord-Küste von Kleinasien. *Zeit. d. Geol. Ges.*, iv., 96-142.
1854. GARELLA ET HUYOT. Rapport sur les Mines de Houille d'Héraclée. *Annales des Mines*, 5th series, vi., p. 173-234.
1856. POOLE (H). On the Coal of the North-western Districts of Asia Minor. *Quart. Journ. Geol. Soc.*
1892. D' HARVENG. Le Bassin Houiller d'Héraclée.
1894. FREYDIES-DUBREUIL. Étude sur le Bassin Houiller d'Héraclée. Lyons.
1895-6. RALLI (G). Le Bassin Houiller d'Héraclée. *Ann. Soc. Géol. de Belgique*, Liege, xxiii., p. 151-267.
1896. DOUVILLÉ (H). Constitution Géologique des Environs d'Héraclée. *Comptes Rendus*, cxxii., part 1, pp. 678-680.
1896. HOLTZER (P). Le Bassin Houiller d'Héraclée. *Bul, Soc. Ind. Min.*, 3rd sér., x, p. 773-823.
1898. KRENKE (G). The Coal Mines of Asia Minor. *Colliery Guardian*, lxxvi., p. 73.
1899-1901. ZEILLER (R). Étude sur la Flore Fossile du Bassin Houiller d'Héraclée. *Soc. Geol. de France, Mém. de Paleont.*, xiii. et ix, No. 21, 91 p.
1902. MUCK. Recherches de Charbon sur la Côte de la Mer Noire. *Org. d. Ver. d. Bortechn*, No. 8, pp. 3-4.
1902. STASSINOPOULOS. Le Bassin Houiller d'Héraclée. *Bull.* No. 189 et 259 *Ch. Com. Fr.* Constantinople, 48 p.
1903. SIMMERSBACK (B). Das Steinkohlenbecken von Heraklea in Kleinasien. *Zeitschr. f. Prakt. Geol.*, xi., pp. 170-172.
1905-6. DE LAUNAY (L). La Formation Charbonneux Infracretacèe des Balkans. *Ann. des Mines*, Mar. 1905, Aug. 1906.
1911. DE LAUNAY (L). La Géologie et les Riches ses Minérales de L'Asie. Paris.

1913. DE LAUNAY (L). Traite de Métallogenie; Gîtes Minéraux et Métallifereres. 3 vols. Paris and Liége.

1913. COAL RESOURCES OF THE WORLD. International Geological Congress. Toronto.

1919. KIRSOPP (J). The Coal Resources of the Near East. *The Near East.* Oct. 10, 1919, p. 393.

IV. MEERSCHAUM.

1849. SMITH (JOHN L.). Chrome and Meerschaum of Asia Minor. *Silliman's Journal* vii., 1849, pp. 285-6.

1851. SMITH (JOHN L.). On the Geology and General Character of the Meerschaum in the Plains of Eski-Shehr (Asia Minor). *Proceedings of the American Association*, 1851, p. 270.

1895. BELLERT (D.). L'Écume de Mer en Asie Mineure. *Revue de Science*, Paris, Section 4, iii., p. 400.

1897. WEINSCHENK (E.). Meerschaum von Eskishehir in Kleinasien. *Zeitschr. f. Kryst.* xxvii., pp. 574-6.

1907. SERBIN (A.). Merskum. *Naturen*, Bergen, xxxi., pp. 117-121.

1909. KATZER (F.). Ueber den Bosnischen Meerschaum. *Berg u. Hütt. Jahresb.*, Wien, lvii., pp. 65-88.

1911. REINHARDT (A.). Ueber Meerschaum und Meerschaum-Fundstätten bei Eskis-Chehir in Kleinasien. *Peterm. Mitt.* lvii., part 2, pp. 251-5.

V. MISCELLANEOUS.

1850. DUFRENCY (O. P. A. P.). Note sur des Cristaux de Diaspore de Gumuch-dagh, près d'Ephèse (Asie Mineure). *Annales des Mines*, xviii., pp. 35 39; *Comptes Rendus*, xxxi., pp. 185-188.

1850. DUFRENOY (O. P. A. P.). Rapport sur un Mémoire de M. Laurence Smith ayant pour Objet l'Étude du Gisement de l'Émeri de l'Asie Mineure, et des Minéraux qui y sont associés. *Comptes Rendus*, xxxi., pp. 611-617.

1894. COULANT (E.). Cenni sul Borato di Calce dell' Asia Minore. *Atti Soc. Tosc. Sci, Nat.*, ix 142.

1902. ANONYMOUS. The Mineral Industry of Turkey. *Quarry*, viii., pp. 508-511.

1903. ACHIARDI (G. d'). Notizie sul Giacimento Cinabrifero di Kara-Barun dell' Asia Minore. *Atti Soc. Tosc. Sci. Nat.*, xiii., pp. 173-6.

1904. FLETT (J. S.). Notes on the Collection of Rock Specimens made by Col. T. English in European Turkey and Asia Minor. *Q.J.G.S.*, lx., pp. 276-277.

1906. SCHMEISSER (K.). Bodenschatze und Bergbau Kleinasiens. *Zeit. f. Prakt. Geol.*, xiv., pp. 186-196.

1908. CESARO (G.). Tellure Natif des Mines de Balia. (Asia Mineure). *Bull. Acad. Roy. Belg.*, pp. 255-257.

1908. SIMMERBACH (B.). Die Mineralvorkommen und die Bergbaulichen Verhaltnisse in Anatolien, Kurdistan, und Arabistan. *Zeit. f. Berg., Hütt., & Salinenwesen*, lvi., pp. 417-421.

1910. ANONYMOUS. The Mineral Resources of Asia Minor. *Mining Journal*, xci., pp. 1202-3.

1912. COULANT (M.E.). Note sur les Mines de Cuivre d'Arghana, Vilayet de Diabékir (Asie Mineure). *Ann. Mines*, mém. ser. 2, ii, pp. 281-293.

1912. COULBEAUX. Gisements de Borate de Chaux d'Asie Mineure. *Ann. Mines*, mém. ser. 2, ii., pp. 94-315.

1912. BAUER (M. H.). Opal von Simav im Nordlichen Kleinasien. *Centralbl. f. Min.*, pp. 511-512

1916. ANONYMOUS. Mineral Wealth of Asia Minor. *The Near East.* May 26.

GLOSSARY.

The following glossary includes nearly all words contained in names occurring in the foregoing article and maps.

Ada	Island
Afium (Afion)	Opium
Aghaj (Aghach)	Tree
Aghyz (Aghizi)	Mouth, outlet
Ak	White
Akar	Flowing (of water)
Ala	High
Alt	Lower or under side
Ano	Upper
Ashaghy	Lower
Bagh	Vineyard
Bair	Spur
Bash	Head
Bazar	Market
Biyuk	Great
Bel	Pass over a mountain range
Bey	Gentleman, master
Boghaz	Gorge, strait
Boz	Grey; bare (of mountains)
Bulak	Spring
Burun (Burnu)	(lit. "nose"), Spur, promontory
Chai	River
Chair	Meadow
Chatal	Split, forked
Cheshme	Fountain, spring
Chiftlik	Farm
Chukur	Hole, low-lying
Dagh	Mountain
Dam	(flat) Roof
Dede	Grandfather, deified ancestor
Delik	Hole
Demir	Iron
Derbend (Devrent)	Pass, police station in a pass
Dere	Valley, stream
Divan	Summer quarters
Duden	Subterranean passage (for stream)
Düz	Flat, level
Egri (Eyri)	Crooked, bent
Elma	Apple
Euzu	Brook
Eski	Old
Euyuh	Tumulus
Gedik	Pass, clearing
Göl (Geul)	Lake
Gümüsh	Silver
Güzel	Beautiful
Hagios (Gk)	Saint
Hammam (Hamam)	Bath-house, bath, hot spring
Hissar	Castle, fort
Ilije	Hot spring
Irmak	River
Iskele (Skala)	Landing-place, railway station
Jebel	Mountain
Kahve	Coffee-house
Kale	Castle, fort, ruin
Kapu	Gate, defile
Kara	Black
Karakol	Police station
Kassaba	Small market town
Kato (Gk)	Lower
Kaya	Rock
Kel	Bald, bare

Khan (Han)	Khan, caravanserai	Serai	Palace
Khoja	Master, teacher	Shehir (Shehr, Shahr)	Town, city
Kilisse	Church	Sirt	Crest
Kiraz (Kirez)	Cherry	Sivri	Sharp, pointed
Köi (Keui)	Village	Su	Water, river
Kol	Arm, branch	Tash	Stone
Küprü ((Keupri)	Bridge	Teke (Tekie, Tekke)	A monastery for dervishes
Küchük	Little, lower	Tepe	Hill
Kul	Servant, slave	Toz	Dust
Kule	Tower, blockhouse	Tuz	Salt
Kush	Bird	Uj	End, point
Kyssa	Short	Ulu	Large
Liman (Gk)	Harbour, bay	Ushak	Servant, knave, peasant
Maden	Mine, metal	Viran (Veran, Veren)	Ruined, ruins
Mal	Treasure	Yagh	Oil
Meidan	Open space, square (in a town)	Yaila	Summer village, mountain pasture
Merkez	Market, administrative centre	Yaka	Bank, border
Mezar	Grave	Yedi	Seven
Muhajjir	Moslem, immigrant	Yel	Wind
Odun	Wood	Yeni	New
Ören (or Euren, Evren, Viran)	Ruins	Yeshil	Green
Orman	Wood, forest	Yilan	Serpent
Orta	Middle	Yokary (Yukari)	Upper
Ova	Plain, meadow	Yrmak (Jrmak)	River
Punar (Bunar)	Spring, fountain	Zeïtin (Zeïtun, Zaïtun)	Olive
Saman	Straw	Ziaret	Sacred, tomb

WATER IN ROCK MAGMAS AND VEINS.

By J. MORROW CAMPBELL, D.Sc., M.Inst.M.M.

The author discusses the theory of water in magmas, and the action of magmatic waters in bringing tin and wolfram to the surface.

INTRODUCTION.—The author's work on "The Ore Minerals of Tavoy," reprinted in The Mining Magazine in February, was made public first as a semi-popular lecture, and for this reason was limited in scope and length. Certain new ideas regarding the origin of water in magmas were put forward and disbelief in the pneumatolytic origin of cassiterite and wolfram expressed, but the observations and arguments in support of these theses were not fully stated.

The work of Mr. W. H. Goodchild on "The Evolution of Ore Deposits from Igneous Magmas" demonstrates how essential water is in the genesis of ores, but he does not deal with the source from which it is derived.

Mr. Coggin Brown cited Gautier's figures as quoted by F. W. Clarke in "Data of Geochemistry" as to the vast amount of water contained in a cubic kilometre of granite. We are concerned firstly with the source of such water and of that given off by magmas and from which ores are deposited.

THE VERTICAL RANGE OF METEORIC WATER IN THE EARTH'S CRUST.—It is curious to observe how much fashion seems to limit the views of even scientific men. Sandberger's theory of lateral secretion was for many years believed by most geologists. It was then accepted that meteoric water traversed the pores of practically all rock to a depth of thousands of feet. Deep shafts and bore-holes revealed the fact that below the first few hundred feet water does not in general penetrate the earth's crust in appreciable quantity. Then, under the lead mostly of American economic geologists, the fashion changed to that of believing the crust to be practically impermeable, that meteoric water cannot get deep down at all, and that water found at great depths is juvenile—of magmatic origin. It is now considered heterodox to even suggest that meteoric water can be a factor in the genesis of primary ores.

THE GENESIS OF ROCK MAGMAS.—In order to deal adequately with the subject we must go back further than Mr. Goodchild does. He commences with what he calls "primary rock magma." This he assumes as being "evolved periodically over large areas beneath the earth's crust by direct oxidation of elemental Mg, Ca, Fe, Al," &c.

Matter, as we know it, was primarily in the state of gas; most of this by cooling passed through a liquid condition before the world took the solid form in which we believe the bulk of it at present exists. The rigidity of the earth forces us to assume the interior to be solid. We know its density is much greater than that of the outer crust, therefore we assume it to be composed largely of the denser elements, that is, metals. Of the interior we have no exact knowledge and, for present purposes, speculation as to its composition is unprofitable. We are concerned only with the outer crust, say 10 miles in depth. This is composed largely of substances which were the last to pass from the gaseous and liquid to the solid condition. As a matter of fact we are dealing with the light, more fusible and volatile odds and ends, so to speak, left over after the great bulk of the matter composing our globe had solidified.

The temperature at which this crustal material assumed the liquid state was very high. A sea consisting almost entirely of anhydrous oxides enveloped the globe and outside it an atmosphere enormous in volume compared with that of to-day. As the temperature fell the atmosphere decreased in volume by combination of its constituents with the liquid envelope; then this solidified. The temperature descended to the boiling-point of water, then the sea formed. Much of the surface water had already been absorbed by the crustal solids, as greedy to unite with it now as they were incapable of doing so when in the gaseous condition. The ocean and the atmosphere will ultimately disappear and another solid, dead planet will revolve in space.

While the material deposited in this liquid crustal layer must have been uniform over the whole surface, vast disturbances in underlying previously solidified layers which took place as cooling proceeded resulted in the admixture locally of non-oxidized, less fusible, and denser material with that of the normal crust. It is probably in this way that the heavier metals have been brought up within our reach.

At very high temperatures oxides cannot exist; therefore it is probable that the interior of the earth is devoid of oxygen. Oxides account for fully 98% of the crust, and of all matter within our reach nearly half is oxygen. There cannot possibly be water in the interior.

The affinity of oxides for water diminishes with increase of temperature; therefore crustal matter when first formed was practically anhydrous. Moreover, it was not fully oxidized, for it solidified largely out of contact with oxygen and at a temperature at which many oxides cannot exist.

The crust thus consists of a very thin surface layer well oxidized and hydrated, its affinity for oxygen and water practically satisfied. Below this we should find combined water in the rocks diminish to zero at a comparatively small depth and the affinity for water increase. Similarly the affinity for oxygen increases as we go down, but oxides would be found at very much greater depths than combined water.

Substances having affinity for one another will, under favourable conditions, combine with one another with evolution of heat.

It is with a deeper layer of the crust—a zone of rock having a strong affinity for both oxygen and water—that Mr. Goodchild starts. This is assumed to be at such a temperature that the oxidation of certain elements in it generates sufficient heat to cause its liquefaction over large areas.

It must be borne in mind that the material which yields Goodchild's "primary rock magma" was itself in the liquid condition, and is the differentiated result of the solidification of primeval liquid rock. It is not possible for rock which has solidified from the liquid state to resume that state without the introduction of a new factor. Oxidation is postulated, but where is oxygen to come from? We cannot imagine any means by which this element, as such, could get access to such depths. But water would be even more effective; its descent is quite conceivable, in fact it appears to be the only possible factor.

Water in such a situation may be absorbed or dissociated; in the latter event the oxygen is taken up in oxidation and the hydrogen occluded; in either case heat is evolved and liquefaction would ensue.

Let us take the simplest possible case and consider we are dealing with the very first primary rock magma formed from primitive material in the world's history. The water necessary could not come from below or any other place but the surface. Meteoric water certainly was the means by which the first rock magma came into existence, and there is every reason to accept it as the factor determining the formation of rock magmas in general; it provides the simplest rational explanation.

We now have reasonable proof that the rocks of the earth's crust are practically impermeable to water, and therefore large volumes of water do not reach great depths by that route. We have strong evidence that they do descend, so we are forced to conclude that they pass down fissures and cracks in the rocks.

There are numerous known instances of earthquakes having produced fissures many miles in length and open many feet in width at the surface. The centre of such disturbances is known to be situated at great depths, and the fissures produced probably persist to almost as great depths. Meteoric water passes down these fissures ; it would be folly to argue otherwise.

Mr. Goodchild says on page 57 of his work : " The fundamental magmatic unit . . . (is) an immense body of magma or intercrustal reservoir derived from the metallosphere by direct oxidation and injected into the lithosphere." There cannot be a sharp line dividing the lithosphere and the metallosphere. There must be a zone of intermediate composition, the metallic content in which, from the lithosphere down, is probably represented by a curve, flat at first, but becoming steep as the metallosphere is approached. From the point where metals are first found (the bottom of the lithosphere) down to the level where oxides are no longer found (the top of the metallosphere) must be several thousands of feet. All this material—lithosphere, intermediate zone, and metallosphere—is the result of differentiation of liquid primeval matter. The several layers from below upward assumed the solid condition at temperatures gradually diminishing. At a later and still cooler stage portions of the metallosphere are assumed to become liquid again. In order that this may be possible, either an increase in temperature must take place or some substance from without must be added that lowers the melting point. We argue that water is the only substance that could gain access.

The assumption that a primary magma may be of ultra-continental dimensions conflicts so strongly with the known rigidity of the earth that one has good reason to be sceptical. It seems difficult to understand wherein lies the imperiousness of the necessity for postulating that which to many geologists must appear so improbable.

On page 60, Mr. Goodchild suggests that a succession of concentrations took place before such magmas as that which yielded the Sudbury ore deposits came into existence. If we assume the ingress of water in limited quantity at successive periods along the same line of weakness this repeated concentration is explained.

Overhead magmatic stoping is the simplest and most rational explanation of the formation of volcanic vents and pipe openings such as those filled with diamondiferous kimberlite in South Africa or the smaller ones in Australia filled with wolfram-bearing rock. Boron and fluorine are given credit for such work ; they doubtless helped, but probably the role of water passing downward to the magma was more important. Magmatic stoping of this type would be produced most readily by the deeper-seated hotter magmas. Such would be very likely to work their way upward along the passage by which water goes down. The old argument that so much heat would be absorbed in vaporization of the water as to bring the process to a standstill, even if it ever started, is based on inadequate knowledge. Water passing down a fissure thousands of feet in depth must necessarily at all points be only slightly below the temperature of the adjacent rock. Below certain depths it is a gas. It is not improbable that at the magma there is, so to speak, a *vis a tergo* (but in the reverse direction of that in plants) drawing the vapour downward to union with the magma. This force would equally tend to draw the magma upward. Goodchild's work demonstrates that water combining with certain compounds such as FeO in a magma, though dissociated, means evolution of heat and increased liquidity owing to the absorption of hydrogen. Thus rock sufficiently hot to combine with water has its temperature raised by it while cooler rock loses heat. Water passing down deep, therefore, transfers heat from upper to lower levels.

The phenomena of volcanism are entirely consistent with this theory. The position of volcanoes is very frequently near the sea, where fissuring of the strata would admit water in practially unlimited quantity, or along known lines of weakness. The enormous volumes of aqueous vapour and of hydrogen discharged by volcanoes are certainly derived from water.

We know there is evidence of the sublimation of silicates in volcanic vents. This involves a temperature of at least 3,500°C, and it is not probable that heat in the magma is less intense. Our knowledge of the behaviour of crustal material in the molten condition above the temperature at which silicates may be sublimed at surface pressure is so scanty that there is no use in speculating as to what takes place in the direction of differentiation in such magmas.

Compared with the above the acid sub-magmas from which cassiterite and wolfram segregated were cool.

MAGMATIC DIFFERENTIATION.—We shall touch on magmatic differentiation, but specially with reference to the acid products and more particularly with the phenomena in this connection observed in the Tavoy District.

The cooling of a rock magma yields products of four general types :

(1) Anhydrous basic rocks, such as gabbro and basalt.

(2) Rocks of intermediate type, such as syenite and andesite.

(3) Hydrated acid rocks, such as granite and rhyolite.

(4) A watery highly acid mother-liquor.

We are ignorant of the percentage of each type an average magma yields. We do not know either the minimum percentage of water necessary for the existence of a magma or the maximum amount it can absorb. The percentage of water in the solid products we know approximately, but have no idea of the amount expelled in the mother-liquor. It is not conceivable that the solid material from which the magma formed could have held in combination all the water contained in its solid differentiates and a considerable surplus as well. The water came from outside.

Since it is the mother-liquor that deposits minerals in veins, it is of interest to know as much as possible about it. It is always highly silicious; sometimes it apparently consists of little else but silica and water, at others all the constituents of granite are present in it. The cause of variation in the nature of the solids carried is not evident; it may be due to concentration, but certainly not to temperature. If very dilute owing to admixture with water it probably can carry silica only, the other granitic constituents being insoluble except in a more concentrated silica-water mixture.

The principal solid products deposited by this liquor on cooling are quartz and pegmatite. Either or both of these are invariably found above a granite batholith; hence we may regard the amount as a rough criterion of the amount of water ejected from the whole or any portion of a batholith. Judging in this way the amount varies within wide limits. This suggests that the granite portion of a magma contains different amounts of water at different parts, and consequently that the absorption of water by the granite sub-magma may be local in character and variable.

The primary magma admittedly contained water. It was liquid for a prolonged period and therefore the ore minerals were at one time fairly evenly distributed through it. The fact that the tin and tungsten minerals are almost entirely contained in the silicious differentiates proves that they are more soluble in the acid than in the basic portion. Since the acid mother-liquor extracts most of these metals from the granitic portion, it follows that they are more soluble in the former. The essential constituents of the mother-liquor are silica and water; therefore it is practically certain that these metals, or rather their oxides, are soluble in a quartz-water mixture at elevated temperature and that on cooling it deposits them as cassiterite, wolfram, and scheelite.

Now this liquid differentiate of magmatic cooling is generally supposed to segregate below the granite which forms a solid roof over it until burst by pressure from below, when it escapes upward. This would seem the normal position for it if the magma received no increment of water after differentiation commenced. There is abundant evidence, however, in the Tavoy District that the aqueous portion did not segregate below the granite. It appears to have been held to a great extent in a band of granite a few hundred feet thick at the upper margin, at the stage when it was only partly solidified, in much the same way that water is held in a sponge. This can be explained only by a steady influx of meteoric water and its absorption locally at points on the periphery. At these points, the sub-magma being more watery than elsewhere, tin and tungsten minerals would collect.

When the granite itself carries these minerals it is in a layer on the periphery and never lower down.

Meteoric Water in Relation to Ore Veins and Mineralized Granite.—The Tavoy tin and wolfram-bearing veins all occur near the periphery of the granite batholiths either:

(1) entirely in the metamorphic rocks,

(2) partly in these and partly in granite, or

(3) entirely in granite.

Kanbauk Mine is an example of type (1) of wolfram occurrence. In no mine of this type where ore-bearing veins are found over 500 ft. up vertically above the granite does the ore persist as far down as the contact.

Hermyingyi Mine is an example of the second type. Here numerous rich veins in the sedimentaries extend down past the contact into the granite, but the average tenor of vein-stuff above the contact is considerably higher than it is below. At the same time the average amount of ore in respect of both number and width of veins diminishes in depth.

As regards type (3), there are many mines in which veins payable in the granite are quite worthless in the overlying metamorphic rocks. In several such occurrences, notably in the drainage area of the Talaingya (Kalonta and Byauk) Chaung, the granite itself at and for some distance below the contact carries not only cassiterite but wolfram, scheelite, bismuthinite, and probably molybdenite also.

Granite has not been observed to carry these minerals except in places where ore-bearing quartz veins are also found in it, and where the extensions of these veins above the contact are barren. Even in such situations it is the exception for granite to be ore-bearing. Magnetite and ilmenite are also found in granite in association with the more valuable minerals, but usually alone.

Aplite dykes carrying both cassiterite and wolfram have been observed in several areas, both in the granite itself and in sedimentaries hundreds of feet above the contact. They are much too low-grade to be of any commercial value.

The great majority of wolfram occurrences exhibit numerous quartz veins only a few hundred feet long, parallel to one another and narrow in width. In several instances in the metamorphic rocks veins are so numerous that considerable quantities of weathered rock *in situ* have been remuneratively worked by ground sluicing.

It is only rarely that isolated, single, wolfram-bearing veins occur. One such yielded some very rich pockets, but not one has proved of real value. In general the veins are in parallel series within strictly circumscribed areas outside which no fissuring has taken place. The vein filling is principally quartz, but almost if not quite invariably mica, usually muscovite, occurs in varying quantity. This mineral, with or without quartz, is often found completely enclosed in cassiterite crystals and more rarely in wolfram. Whenever a number of parallel veins occur close to one another they are invariably mineralized.

Pegmatite occurs in veins, filling cracks and fissures in granite and more rarely in sedimentary rocks; also as lenses in veins otherwise consisting essentially of quartz, and there is usually a fairly sharp line separating it from the quartz. Pegmatite of this (high temperature) type is not coarse-grained and is very often highly mineralized. Zinba Mine yields very fine specimens (from lenses in quartz veins) containing wolfram, scheelite, molybdenite, bismuthinite, pyrite, and chalcopyrite.

Pegmatite of a totally different type is also found. It occurs as a layer along the granite contact. This often contains tourmaline, but does not carry tin ore or wolfram. It not infrequently merges into almost pure quartz of characteristic mammillary structure, each prominence consisting of radiating quartz crystals. In one locality this has developed in successive layers to a thickness of over 200 ft.

The two types of pegmatite belong to different periods. The former develops early, and is always associated with wolfram or tin; whereas the latter or contact type is of later origin and is rarely found on ore-bearing areas.

To summarize, we find aplite dykes, pegmatite veins, and patches of granite on the upper margin of batholiths all carrying tin ore and wolfram, but only in the vicinity of mineralized quartz veins. Tin and tungsten minerals usually occur within small circumscribed areas and the veins containing them are narrow, numerous, and parallel to one another; or there may be two series differently orientated crossing in the same area. When aplite dykes exist they always occupy the oldest fissures.

These phenomena seem to be explicable only on the hypothesis that meteoric water reached the granitic portion of the magma in varying quantity and at definite points during the differentiation period.

The material forming aplite dykes was ejected at a period when the magma contained an amount of water not much in excess of that necessary to keep it fluid. When more water was absorbed, liquor yielding mineralized pegmatite and quartz was expelled, and when the temperature had fallen below that at which the liquor could carry heavy ore minerals in solution, barren quartz veins and contact pegmatite came into existence.

Quartz veins in tin and wolfram-bearing granite, while ore-bearing up to the contact, are barren immediately they enter the sedimentaries. This indicates that the latter have never been raised to a temperature sufficiently high to permit the magmatic liquid to retain the ores in solution in them; all were deposited in veins in the granite. Cooling was for some reason so rapid that the upper layer of the granite—a concentrated tin and tungsten solution—solidified, retaining the metals, while lower portions remained liquid long enough to allow the ore minerals to be squeezed out in solution in the mother-liquor from which they were deposited in veins in the granite above. This represents the extreme of low temperature conditions where the ore minerals never escape from the batholith.

The extreme of high temperature conditions is represented by mines such as Kanbauk and the Kadwe series. In the latter, wolfram-bearing aplite dykes occur hundreds of feet up in the sedimentary rocks. These strata have all been heated to a point sufficiently high to allow the upward passage through them of the ore-bearing solution which deposited its wolfram fully 500 ft. above the granite. At this extreme we find all the ore expelled in solution from the batholith and deposited hundreds of feet above in veins in overlying rocks.

The part of the magma which, when solidified, we find in aplite dykes and mineralized granite formed at the upper margin and seems to have been the result of concentration of the metals around points where meteoric water reached the magma. With the extreme of high temperature this ore-bearing magma was forced up for hundreds of feet through fissures in overlying beds, whereas with the extreme of low temperature it was further enriched, and solidified *in situ*.

Tin and tungsten minerals at Tavoy appear to have been gradually leached and collected in small well-defined areas (or more rarely along lines) on the granite periphery, at which surface water entered, and that the conditions at those points determined the mode and position in which the ores developed.

PNEUMATOLYSIS.—This theory has been very much overworked, since it is a convenient method of explaining processes of an obscure nature. It has also been fashionable, and therefore has a numerous following, most of whom have not troubled to either doubt or prove its applicability. The principal reason why it has held the field as explaining the origin of tin ore in veins is due to the fact that tourmaline, fluorite, apatite, and other boron, fluorine, and chlorine-bearing minerals have practically invariably been found in close association with cassiterite. These elements form gaseous compounds with tin which may carry it upward from magmas to veins, whereas its transport in aqueous solution was regarded as impossible.

The Tavoy veins that carry cassiterite show very little fluorite, apatite is rarely seen, and tourmaline is unknown. Many veins carrying no ore minerals contain not only fluorite but tourmaline in large quantities. These phenomena have perturbed followers of the pneumatolytic theory, who have suggested sulphides, &c., as carriers or mineralizers, but still appear to believe that the fluorides, &c., occurring elsewhere have a genetic connection with the cassiterite that accompanies them.

Since it is evident from the phenomena of Tavoy veins that cassiterite develops in veins and elsewhere without the agency of fluorine, etc., it must be admitted that there is good reason to believe the association of tourmaline, fluorides, etc., with cassiterite to be fortuitous and not genetic. There can hardly be two modes of origin of cassiterite, one for Tavoy and another elsewhere.

The pneumatolytic theory has not been used so much to explain the origin of tungsten minerals as of cassiterite, and this is largely because, until lately, few people have troubled to study the genesis of the former.

Since cassiterite and wolfram occur in veins together quite commonly, and as there certainly is very little difference between the temperatures at which they are deposited (wolfram having been proved in some cases to be a higher temperature mineral than cassiterite), it is evident that if cassiterite is of pneumatolytic origin, wolfram must of necessity be also; they are quite obviously homogenetic.

All the evidence provided by Tavoy deposits indicates that both tin and tungsten minerals were segregated from the magma and borne thence in silico-aqueous solution to the positions in which we find them. On the other hand many of the phenomena are quite irreconcilable with the introduction of these minerals in the gaseous condition; for instance, the presence of cassiterite and wolfram as primary minerals in granite, aplite, and pegmatite, also the existence of mica inside cassiterite and wolfram crystals, the latter completely surrounding it.

Pneumatolysis involves the carrying of substances in the form of gas along with water, also in the gaseous condition, from the magma to some point where the temperature is low enough to permit the two gases to react with one another and produce a solid which is deposited near this point, the carrier being liberated to combine in accordance with local conditions; it does not return to its point of departure, that is, it brings only one load. Whatever carrier may be postulated for tin, the other gas was water, and, in order that the process may work, both the tin compound and water must remain in the gaseous condition as long as they are moving upward. This means that the temperature throughout the pneumatolytic system must be above the critical point of water. This point rises with increased pressure, and we are safe in assuming that in positions where tin oxide could be deposited the critical point of water is not below 350°. We know that both wolfram and cassiterite as fluids pass up vein fissures entirely in sedimentary rocks often over 500 ft. vertical. Pneumatolysis would require all this rock to be heated up to over 350°C. It is not possible to believe that this has taken place, because prolonged heating in the presence of water at such a temperature would produce intense local metamorphism of the country rock. There is no evidence of this. The only change to be observed is on the vein walls which, in the argillaceous sedimentaries, are often silicified to a depth of perhaps half an inch. Even in places where the mineralized veins are very numerous and only a few inches apart, the intervening rock shows no signs of metamorphism, not differing in any way from that far distant from veins.

In some cases intense local metamorphism, resulting in the formation of crystalline (andalusite and mica) schists, is to be observed near the granite contact, but even there it is the exception rather than the rule. Andalusite schist has often been found near the contact, but far below the level of ore-bearing veins. Where the granite itself is mineralized, the sedimentaries in contact with it show no signs whatever of local metamorphism.

These facts lead us to believe that the temperature of deposition of these ores in veins in the sedimentaries was below that at which pneumatolysis would be possible.

Pneumatolysis failing, our only alternative is to accept the silica-water mother-liquor as the vehicle in which tin and tungsten minerals were both concentrated locally in the granite or carried upward to veins perhaps a thousand feet above.

VEIN FISSURING.—We have seen that the acid magmatic differentiate on solidification often contains much more water than it can combine with, and also a quantity varying greatly in different cases. This is discharged upward through fissures produced by expansion within the magma. The phenomena of the occurrence of products derived from this mother-liquor prove that the superabundance of water existed principally in the upper margin of the granite and notably in areas in which mineralized veins occur. In the same areas mineralized aplite dykes and pegmatite occur, and not elsewhere, but at other places isolated barren quartz veins and sheets of pegmatite are found. The mother-liquor which carried the ore minerals came from the surface of the magma, not from low down. At the time this was ejected the temperature was fairly high, but the magma could not have contained surplus water at any other part; otherwise the ore minerals could not have been concentrated exclusively at the surface. The fact that the same magma at a later stage gave off considerable further volumes of water indicates that this must have been absorbed subsequently to the extrusion of the ore-bearing mother-liquor, and at a temperature too low to permit it carrying tin and tungsten in solution.

These phenomena seem to indicate that the granite sub-magma absorbed water at its surface at certain points at several different periods before its solidification, and at the points of absorption, while the temperature was still sufficiently high to permit ore minerals to be carried in solution, pressure, being greater than at other parts, caused fissuring in small isolated areas.

While in general the strike of the ore-bearing veins conforms with that of the axis of the batholiths there are many exceptions. It is not uncommon to find two series of parallel veins differently oriented in the same area in addition to aplite dykes. This indicates that fissuring took place three times during the period when wolfram was being expelled in solution.

If the force producing fissuring within the batholith, as is generally supposed, was deep-seated, it is not possible for a number of parallel veins all within a circle of less than 400 ft. radius and at a known vertical distance of about 600 ft. above the granite periphery to be formed. The force, moreover, must have been intense and concentrated within a very small area around a point or along a short line.

PERSISTENCE OF WOLFRAM IN DEPTH.—A feature having an important bearing on discussion of the persistence in depth of the Tavoy wolfram veins that has not yet been noted is that the great majority of valleys in the district are tectonic and in only a minor degree the result of erosion.

It has been assumed that because the outcrop of a vein is seen to be continuous from the summit to the base of a granite hill several hundred feet high, it persists for an equal vertical depth. It does not. The explanation is that the slope of the hill-side down which the outcrop runs is usually practically parallel to and not far below the original granite periphery, the overlying sedimentaries and only a very little granite having been removed by denudation. Near the bottom of such hills, in every case investigated by the writer, sedimentary rocks were found at no great distance.

Persistence to a depth of 1,000 ft. has not yet been proved in any Tavoy vein and, while possible in only a few cases, is improbable. In the great majority of the veins already opened up values disappear at small depth. With a few exceptions very little profit has been yielded by veins at a depth of 200 ft. Unfortunately it must be admitted that not only experience in the mines but deductions from the phenomena of the occurrence of the ores compel us to regard the mineralized zone in the Tavoy District as being of small vertical extent.

NEWS LETTERS.

TORONTO.

November 12.

PORCUPINE.—Production at this camp is still curtailed by labour shortage, owing to which the leading mines are operating considerably below capacity. It is estimated that 2,000 men could easily find employment in the district. In order to meet the difficulty the Hollinger Consolidated and the McIntyre are installing mechanical shovelling machines to load the cars after blasting. This is the first time that these machines have been employed in Canada for underground work. The Dome has succeeded in considerably reducing the cost of production owing to its improved equipment for ore handling. With a working force of about 300 men it is treating about 1,000 tons of ore per day, and working at about two-thirds capacity. Mill-heads are understood to average about $8 per ton, and it is strongly anticipated that the payment of dividends will be resumed in January. Preparationsare being made to draw ore from the stopes on the Dome Extension for treatment at the Dome mill. Two stopes are on the 600 ft. level, one of which shows the ore-body to have a width of about 100 ft., and the other somewhat less. The main shaft of the McIntyre is down to the 1,500 ft. level, at which depth rich ore occurs. Development work on the 1,125 ft. level has opened up an ore-shoot 920 ft. long and 30 ft. in width, carrying $18 to the ton. The shaft on the Big Dyke will be sunk to the 300 ft. level. The Gold Reef has increased its capital from $1,000,000 to $3,000,000. At the Davidson the main vein has been cross-cut at the 600 ft. level, and is reported to show increased enrichment. The shaft will be continued to a depth of 1,000 ft. Good ore is being opened up on three veins of the Clifton-Porcupine on the 100 ft. level.

KIRKLAND LAKE.—The strike of miners was formally called off on October 15, but for some time previous many of the men had been returning to work, and activity was speedily resumed. The Lake Shore, Kirkland Lake, and Teck Hughes have secured all the labour they require. The shaft of the Lake Shore is to be put down from its present depth of 400 ft. to 600 ft. The mill of the Kirkland Lake is operating at capacity, treating about 150 tons per day. The main shaft is being put down to the 700 ft. level. The Crown Reserve has resumed work on the Canadian Kirkland, on which it holds an option. On the Kirkland Bidgood eleven veins have been discovered, varying in width from a few inches to 2 ft., some of them carrying promising gold contents. The construction of the big mill of the Wright-Hargreaves will not be proceeded with this year. Diamond-drilling will be started immediately on the Greene-Kirkland, and test pits sunk on veins found on the surface. A shaft is being sunk on the Kirkland-Combine, where diamond-drilling has encountered ore at 300 ft.

COBALT.—Stimulated by the high price of silver, production shows a considerable increase. It is estimated that the mines of the district are producing at the rate of upwards of $40,000 in value in every 24 hours. Labour conditions are more favourable than in the gold-mining camps, and plenty of efficient workers are available. The Nipissing has established a new high record, producing at the rate of about $500 per hour. Underground work is almost back to normal, though some of the lower levels have yet to be unwatered. During October the production of ore had an estimated value of $575,247, and shipments of bullion and residue from Nipissing and customs ore had an estimated net value of $680,208. The La Rose Consolidated has greatly improved its position latterly. Four of the company's properties are producing both high and low-grade ore, and some important finds have been made, including a 7 in. high-grade vein on the 100 ft. level of the University property. The Nipissing Extension (formerly the Farah) is being unwatered preparatory to active development. A new vein has been found on the surface. At the Beaver a vein carrying 4,500 oz. ore has been found on the 200 ft. level and another carrying 2,500 oz. to the ton at the 700 ft. level. A discovery of high-grade ore has been made at the Silver Cliff mine, which is operated under lease by the Northern Customs Co.

GOWGANDA.—This district is attracting much attention among mining men on account of recent important discoveries, the latest of which is a 6 in. vein on the Castle, stated to yield very high assays. The Trethewey, of Cobalt, has completed arrangements for taking over the Castle, giving the shareholders of that company one share in the Trethewey for every two shares of the Castle. The Trethewey has also taken an option on the Major property, including 112 acres underlying Miller Lake. The Camburn, Collins, McDonald, and other new prospects are being actively developed. Hitherto transportation difficulties have stood in the way of the development of the district, but these will shortly be overcome by the construction of a light railway, of the type used in the war zone, between Elk Lake and Gowganda.

BOSTON CREEK.—The Miller Independence has decided to construct a first-class road from Boston Creek station to the mines. A new vein has been encountered in the shaft, stated to assay $56 to the ton. The Boston McCrea will carry on active developmeut through the winter. A shaft is being put down to the 100 ft. level. A company is being formed to develop the Kennedy group of claims north of the Boston McCrea, where the surface veins have given good assays.

MELBOURNE.

September 25.

WEST AUSTRALIAN BASE METALS. — Last month I gave some particulars of the agitation in West Australia for the establishment of a State smelting plant at Geraldton, the object to be gained being the avoidance of the high charges of the eastern smelters and the cost of freight. It will be remembered that the new law prohibits the shipment of ores to other parts of the world. A report on the matter has been made by the State Mining Engineer, Mr. A. Montgomery, and as the question is of considerable importance, I quote his views at some length.

Mr. Montgomery points out that the Northampton lead-bearing district is quite fifty miles in length, and that the lead mines are scattered over a large area. The ore is usually in somewhat small lodes, individually not capable of supplying enough ore to keep a smelting works in action, and will therefore best be dealt with at a common smelting centre. The ore is mainly galena, much of which is high grade, and easily separated by hand picking, while the second-class ore can be concentrated easily and cheaply to a high-grade product. It is much more economical to concentrate the lower-grade ore on the mines, and smelt only the concentrates therefrom, than to smelt the same ore as it comes from the mine. A concentration plant at each mine, or centrally situated in each group of mines, is therefore the first requisite for treating the ore successfully, not a smelting plant.

With regard to the argument that the provision of a State smelter will so stimulate the production of the lead ore that plenty will be available for keeping the works going, Mr. Montgomery says that this argument has been used with equal confidence over and over again in connection with State batteries, water-supply questions, railways, and so on, but that it is difficult to find a case in which it has been justified. The Northampton field is capable of a very greatly increased production of lead, and if the mines were adequately worked there would be no fear of supplies of ore falling short of the demands of a much larger smelting furnace than any at present under contemplation; but before that stage is reached there must be company organization of the field, and extensive development with the aid of subscribed capital expenditure. This is not yet in sight. If it should come about that a number of companies were formed to work the Northampton lodes, it does not necessarily follow that they would make use of a local smelter, if one were established. Under existing conditions the export of lead has been prohibited, and the Federal Government has expressed their intention of having all Australian lead ores smelted in Australia. But, says Mr. Montgomery, we must look forward to happier times when the export of ore may be again permitted.

Prior to the war and the prohibition of lead ore export, the Fremantle Trading Co., although they had smelting works of their own, preferred to export their ore to be smelted in England, where smelting could be done much more cheaply than in Australia. If free export at pre-war rates were to become possible now, the ore would again be exported. The same considerations of the best markets available would make other owners of lead mines follow the same course and export their ore instead of smelting it in Australia. To see why they should do so we have to return to the consideration that the most profitable product of the mines is dressed or concentrated lead ore, not crude ore, and that the material to be shipped will average fully 70% lead. The Australian consumption of lead is not great, and the bulk of the metal will have to be exported to Europe in any case. The question of freights narrows itself to a comparison of the relative costs of freight of 100 tons of lead ore as against 70 tons of metallic lead, and as the latter is the more valuable material the charge for freight will probably be somewhat greater per ton. Outside of the freights the smelting costs in Australia come into direct comparison with those in England. The figures to be compared are, therefore: cost of smelting 100 tons of lead ore in Western Australia, plus cost of shipping 70 tons of lead therefrom to England, against cost of shipping 100 tons of lead ore to England, plus cost of smelting 100 tons of lead ore there. Even suppose that the prohibition of export of lead ore to Europe be continued, the same consideration comes in when comparing local smelting in West Australia with smelting in the Eastern States of the Commonwealth. A company selling its concentrates would have to compare: cost of smelting 100 tons lead ore in W.A., plus cost of shipping 70 tons lead to foreign market for sale, against cost of sending 100 tons lead ore to Eastern States, plus cost of smelting 100 tons lead ore in Eastern States, plus cost of shipping 70 tons lead ore from Eastern States to foreign market for sale.

It is to be borne in mind that the rates of freight from the Eastern States are usually decidedly lower than those from West Australia, even by the same vessels. The advantage of smelting in W.A., if smelting costs were equal, is therefore somewhat less than the extra cost of shipping from W.A. to the Eastern smelting works, and the latter are undoubtedly able to smelt more cheaply than can be done in West Australia. If the competition for ore were to become at all keen, it might very easily come about that mine-owners at Northampton could obtain shipping rates to the Eastern smelters and smelting rates which would render it impossible for the West Australian smelting works to compete.

The fact is that concentrated lead ore is a marketable commodity almost as readily saleable as the lead extracted from it, and that the real question for consideration is whether local smelting will give a more profitable return than shipping the concentrates. Under immediately existing terms of smelting in the Eastern States there appears to be a good deal of advantage in smelting locally, and probably this would continue if sufficiently large smelting works could be maintained in operation; but, if competition were to become keen between the larger works, it might easily come about that the local smelter, if a small one, could not hold its customers. So far as can be ascertained the smelting and purchase tariffs of the two principal public lead-smelting establishments in Eastern Australia, the Sulphide Corporation's works at Cockle Creek, and the Associated Smelters' works at Port Pirie, have not been altered seriously from those quoted in the Departmental bulletin on "Sale of Ores and Minerals" issued early in 1917, although increase in wages and prices of coal and coke will doubtless have made them somewhat higher now than then. Taking an average Northampton ore of 70% lead and London value of lead at £30 per ton, the costs of smelting at the above two works and the Fremantle smelting works would be as follows, according to the tariffs explained in the bulletin:

	Per ton of Ore £	s.	d.
Associated Smelters	8	12	8
Sulphide Corporation	8	2	9
Fremantle Smelter	8	2	0

These charges are the amount to be deducted from the full assay-value of the ore at £30 per ton of lead, inclusive of all allowances, losses, deductions, etc. The figure of £6. 5s. 5d. per ton of ore, quoted in the bulletin, for lead shipments to Great Britain in 1915, is very nearly on the same basis as the above, and may be fairly compared with them. Shipping and agency charges from Fremantle, however, have to be added, about £2. 18s. 6d. per ton, thus making the total cost £9. 3s. 11d. per ton. Taking into account that the shipping charges from Fremantle to the Associated Smelters and Sulphide Corporation, including wharfage, agency, insurance, freight, and landing charges have rarely been under £2 per ton, the real comparison would be:

	Per ton of Ore £	s.	d.
Associated Smelters	10	12	8
Sulphide Corporation	10	2	9
Smelters in England.........	9	3	11
Fremantle Smelter	8	2	0

In accordance with their agreement with the Government the Fremantle Trading Co. supply their figures of working costs, in summary form, every month confidentially to the Mines Department, but not for publication. From these it is known that the profit on treating lead ores for the public is not large, and is not more than a very reasonable allowance. The demand for a local smelter at Geraldton is founded on a mistaken idea that the Fremantle Trading Company is making large profits out of the smelting, which their figures show is not the case at all; on an unworthy and unfounded suspicion that they do not give their customers a fair deal, which has never been substantiated in the slightest; on local interest in desiring to have a large wages-expending industry in Geraldton rather than in Fremantle; and on want of knowledge of the real costs of smelting and marketing lead. When the smelting charge is quoted as £4. 7s. 6d. per ton, as in the British case quoted in the bulletin, it is somewhat startling to a seller to find that the charges at the smelting works are really £6. 5s. 5d. per ton, as therein shown, and it is apt to be forgotten that it will cost the seller £2. 18s. 6d. per ton to get his ore into the smelter's hands from Fremantle. Similarly, the bulletin shows that the Sulphide

Corporation's smelting charges were being stated as about 45s. per ton of ore, while their actual total charges, reckoned against the full assay-value of the ore, were from, say, £7. 15s. to £9. 7s. 6d. per ton. Smelting charges are variously expressed by smelters, and in order to see what they really are it is always necessary to work out an actual instance, comparing the full assay-value per ton of ore with the value as calculated on the smelter's tariff. The difference of the two values is the real cost of smelting and realization. It should not be forgotten that the smelter has to send his lead, for the most part, to foreign markets, and has, therefore, to pay expenses of transport and sale, not reckoned upon by the seller of the ore. Owing to the time which elapses between the date of purchase of the ore and the date on which the smelter gets paid for the lead made from it, the item of interest is also quite a serious one, though commonly thought to be of little moment.

Mr. Montgomery concludes by saying that at the present time there is not room for more than one lead-smelting works in West Australia, and the one which has been running for some years deserves to be encouraged. It could deal with double as much ore as it now gets, and could then reduce its costs appreciably. There is no sound reason for believing that the establishment of a State smelter at Geraldton would be of any advantage to the producers of ore, if worked on a proper basis of paying its way. The great savings expected to be made do not exist.

NORTH OF ENGLAND.

The Commission.—It is not difficult to guess the nature of the evidence furnished by the mine proprietors in support of the case which they put before the Commission inquiring into the position of the non-ferrous mines of the country, and it is perhaps interesting and even informing to recapitulate the points upon which stress naturally would be laid. What was said on behalf of the Lake Country mines applied in the main to the industry in other parts of the North of England. All the mines are working on a subnormal scale, and could rapidly increase their outputs, and would engage additional labour if the bonus were immediately granted on the terms of the general application. The North of England has increased its percentage to some extent in recent years, and is the principal producer of zinc concentrates. The rapid advances in rates of wages granted in coal and iron-ore mining were imposed on the lead and zinc mines without any application from the men, but because the Government had paid these higher wages to the coal and iron-ore mines, quite failing to appreciate the difference of the conditions. There is no doubt that a general slackness has resulted throughout the industry, accompanied by complete uncertainty as to the future in the minds of the owners. It has been quite impossible to lay out any considered policy of working, the decisions of the Government being promulgated without notice and without consultation.

Active steps are being taken to open up the Brundholme mines under the direction of Mr. Borlase, who is sinking an exploratory shaft to the depth of 30 fathoms. The adjoining property, Threlkeld, is being developed, and has a small regular output, under the supervision of Mr. Anthony Wilson. A new area of bearing ground has been discovered and will necessitate considerable modification of the present plant. This mine will be a producer on a fairly large scale, say, 1,000 tons per annum within two years. Force Crag mine is going to work on a much larger scale with a produce of barytes, galena, and flotation zinc concentrates. The old lodes in the Newlands valley are being thoroughly explored under Mr. Bennett Johns, and Thornthwaite has started a scheme of development in the hope of locating new areas of bearing lode north and south of the present workings. There are several abandoned mines in the Keswick district which have potentialities and which would be tried in favourable conditions. There is in addition the large Caldbeck area where a company was practically formed but fell through because of the uncertainty of the future. With any settled policy these mines should work again, as they have only been superficially exploited.

Water power is an important factor. Greenside is run by an excellent combination of water power and electricity. Nenthead has a system of hydraulic air compression and the finest steam-power plant in the district; Threlkeld has no water power and uses a gas engine; Brundholme has a moderate water supply; Force Crag has water and a producer gas plant; Thornthwaite has a good but rather intermittent water supply, and also steam and gas engines; the best source of water power is in the Caldbeck area, where there is enough supply from the River Caldew to run the whole series of mines. There is a difficulty in the long distance to markets, Brand's Spelter Works being the nearest for zinc concentrates, and St. Helen's for galena. Any higher basis of railway rates would be a serious matter.

Generally the mines are worked with great economy, and the dressing installations are fairly up-to-date, but rather run down by lack of sufficient repairs during and since the war. It will take some time to get this put right. For instance, the tables at Thornthwaite require replacing and a new slime plant is required at Threlkeld. Force Crag might replace its present Elmore plant with a more modern type, and there are possible improvements at Nenthead. The great thing is to give some security for markets and price and to relieve the industry from the intolerable burdens which now hamper it.

No accurate forecast can be made of the cost of working. For instance, at Force Crag, where a rating appeal has just been settled, the company has to accept an assessment for rates upon its dead rent of £200; with a rate of say 9s. in the £, an annual payment of £90 has to be paid in rates. This may seem a small matter, but in exploratory work it adds considerably to the risk, and should not be payable. The Committee should realize that in starting to open up a mine there is no absolute certainty that a deposit, rich enough to pay for the working, will be found. Such exploratory ventures must be carried out by individuals, generally with small capital. A substantial capital cannot be made possible until the deposit is successfully located, and then it is only partly proved. A long period of investigation should be the preliminary to any erection of permanent plant, but this is generally avoided by starting a small dressing floor in order to obtain some revenue. The dead rent and rates are, of course, a factor in the policy that almost invariably obtains.

There are extensive deposits of galena and blende in the Keswick district, and these could be found and worked if a well thought out scheme were adopted. The cost would be heavy, but the reward would be large. The Thornthwaite-Brandlehow series of veins have only been scratched, and it is said that they bear in other places than where worked at present, or in the past by others. In addition to this district, there is an enormous area on the Caldbeck Fells. This has generally been exploited down to the water level and only for lead and copper ores. The mines were abandoned about 70 years ago, but neither blende nor barytes were then of any value, and as the lodes contain a mixture of the three minerals only one product of three was recovered. A very large production could be obtained of all these minerals with some small amount of copper. There is then the Patterdale area where mines other than Greenside were worked, and all these could be managed from one office. There is also a small group near to Appleby. The galena is associated with barytes, now a payable proposition, and the Silver Band mine is being started at the present time.

The question may arise as to what prospect there may be of increasing production, and of reducing the costs without reducing the wages. The Government has fixed the present rates until September, 1920, and until that date no modification of the basis can be considered. If successful mining is to be carried out, labour must cordially co-operate, and to gain this it may be advisable to give the employees some clearer idea of the situation. There are so many expenses beyond actual mechanical operations that a definite course of education would have to be undertaken before the position could be rightly understood. The actual divisible profit is so much smaller than the nominal profit that some definite basis should be arrived at, in which the interests of the shareholders are properly protected, and after this the actual workers of all classes should participate in such margin as remains. If labour has already extracted the maximum that the industry can afford, there is no room for sharing profits. There should be a reasonable basis of wages, ample depreciation on plant, ample amortization of buildings, land, shafts, and development, a minimum rate of interest on capital, and the amount payable to men should not be subject to income tax.

THE MINES.—The developments at Threlkeld mine are proceeding very satisfactorily. The main Horse Level is being steadily extended, and this week a very good rib of lead was cut, giving about three tons to the fathom. This, of course, will be thoroughly payable at the present price of lead, and it is to be hoped that this run of ore may extend for some considerable distance. The stopes are also improving as they go up. The proprietors have agreed to provide additional capital for the purpose of carrying the developments on at a much greater speed, in order to get the mine opened out by next year. At Thornthwaite mines, the higher price of lead has enabled the company to engage a few extra men and the output should increase somewhat in the next few months. At Force Crag matters are looking better. The developments underground appear to be of a favourable nature, and within a month or two the output of blende will probably rise to a fairly substantial tonnage. With regard to the Nenthead mines, work there has very largely been suspended.

LEAD.—The price of lead has now reached a figure which will enable mines to work at a profit, and there should be a distinct revival in this branch of the industry. There is a world-wide shortage of lead and the price will go up further. At the present rate of exchange lead cannot be bought in America to compete with the present level of prices here, the Spanish output is being absorbed by Italy and France, and the Australian output has temporarily ceased. The present level of lead of course affects the blende mines to the extent of their proportion of galena to the whole output of concentrates. As an example, above one-third of the output from Thornthwaite mine is lead, and a rise in price of £3 on galena equals £1 per ton on the whole output.

CAMBORNE.

GEEVOR TIN MINES.—The result of the development work carried out in these mines and described in the mine manager's reports dated August 8 and October 31, 1919, respectively, would appear to justify the confidence of Mr. Wethered that Geevor in the not far distant future will rival East Pool in the matter of production. We cannot recall reading the report of a Cornish mine where, to judge from the reports of Mr. W. C. Williams, such consistently payable values have been secured from practically all the lode developments.

The development for the year ended March 31, 1919, amounted to 3,267 ft., all of which, with the exception of 280 ft., was on lode. From eleven different ends, as recorded in the reports, the assay-value averages 42 lb. black tin over a width of 3 ft. The ore reserves are estimated at 144,000 tons, or over five years' supply for the present mill, but the manager is very confident that the 7th level will open up large supplies of ore, and also that the western section of Geevor (which will be tested from the Victory shaft now being sunk) and Wheal Carne (now being unwatered) will furnish considerable quantities of ore of at least average milling value. It would be interesting to know the average assay-value of the ore reserve referred to. In the absence of this information, in view of the fluctuating price of the metal, and also of the operating cost, the figure of quantity is of little value. On the hypothesis that his anticipations will be realized, the manager expresses the opinion that the monthly capacity of the mine is 8,000 tons, with an estimated yield of 120 tons of black tin (average recovery 33 lb. per ton). Mr. Williams is evidently a courageous as well as an optimistic man. We hope his anticipations may be realized, but for our own part we would rather see the ore actually blocked out before increasing the milling power to the extent named. However, there can be no doubt that the developments of the past year have been most satisfactory, and from the expressed opinions of engineers who have visited the property (the report of Mr. Josiah Paull is given elsewhere in this issue), we have confidence that, given the present price of tin and working costs, the mine will make a good showing and warrant the increased capital.

For the twelve months ended March 31 last, the tonnage milled was 25,919, from which was produced 439 tons of tin oxide, or a recovery of 37·9 lb. per ton. The average price realized was £174, or in all £76,514. The operating cost at the mine figures at 37s. 4d. per ton, but, in addition, administration costs were 1s. 5d., and debenture interest, income tax, and depreciation equalled 6s. 8d. per ton, so that the total cost works out at 45s. 5d. per ton. The net profit was £17,854. The financial position, as judged by the balance sheet, did not justify the payment of the further dividend recommended, but presumably this was to be provided out of the profits earned since March 31 last, although it was not made clear. We would suggest that the accounts might easily be presented earlier another year. It is not as though the mine were situated in the Antipodes.

At the meeting, the shareholders agreed to increase the capital from £90,000 to £180,000, and as the shares are to be issued at 5s. premium, this means the provision of the substantial sum of £135,000, so that the company for the first time will be adequately provided with funds. In view of the proposed heavy capital expenditure, the lords have agreed, for 12 months at least, to reduce the royalties from one twenty-fourth to one-fortieth of the value of the mineral produced.

NON-FERROUS MINES COMMISSION.—The Commission has now completed the work of hearing the evidence relating to the tin-mining industry. The members recently paid a brief visit to some of the mines to enable those Commissioners who had little first-hand knowledge of the industry to gain some information on the spot. No further concrete proposals as to the nature of the assistance desired appear to have been submitted by the later witnesses, unless indeed the suggestion of Mr. Oliver Wethered that a loan should be made by the Government at a low rate of interest with repayment deferred for at least twenty-five years is so regarded. On one point all the witnesses seem agreed, and that is that owing to conditions brought about by the war, the development of the mines got very much in arrear, with a resultant fall in the produce. As anticipated in the last issue, the Commissioners have agreed to prepare and present an interim report dealing with the tin-mining industry, and we can now only possess our souls in patience and hope that they will be able to produce recommendations that will be of practical value to the industry and at the same time of such a nature as will command the support of the Government.

STRIKE OF MINERS AT DOLCOATH.—For some time past the question of short time has been before the Joint Industrial Council as a result of complaints by the employers. The remedy suggested by the representatives of the Unions was that the employers should insist on all their men becoming members of the respective Unions; thus the recalcitrant ones could be dealt with by the Union concerned. Verbal agreement appears to have been made with Mr. J. Harris, of the Workers' Union, that tributers should work 23 shifts per month. On this understanding, the management of Dolcoath issued a notice that if tributers would not agree to work this number of shifts per month, no contracts would be made. The result was that the underground men came out on strike as a protest, they holding the opinion that 20 shifts per month were as many as could be reasonably expected in a deep and hot mine like Dolcoath. When one considers the nature of the work and present-day conditions in other industries, there is a good deal to be said from the men's point of view. Greater output is absolutely necessary if the mines are to continue, but the managements should aim at higher efficiency on the lesser number of shifts. This is, of course, more difficult in the case of tributers than with men on ordinary contract work, although our own experience is that it is the latter class of men who are the greatest delinquents. However, we should certainly not hold that a fixed minimum number of attendances underground was a way likely necessarily to lead to increased output. As a result of the strike, the manager of Dolcoath appears to have withdrawn—temporarily, at any rate—the notice which caused the trouble. The Union officials seem to have got into hot water for their share in the matter, and they are now busily engaged in trying to convince the members that no such agreement was approved by them.

TINCROFT.—It is very satisfactory to be assured officially that "receipts and expenditure about balance" at this mine. This is mainly due to the improved prices for both tin and arsenic, but the shareholders will be encouraged by the improvement in ore values at the bottom of the mine, as indicated in the last issue.

The report and statement of account for the half-year ended June 30 last will not be issued, but one for the full year will be published early in 1920. It is a pity to have spoilt the sequence of half-yearly reports, just because the account would not have made palatable reading. This is usually the resource of the "wild cat" variety of company, and we are sorry to see Tincroft adopt the procedure. The tight financial condition of the company at the time was no secret locally.

SUGGESTED AMALGAMATION OF CORNISH SCIENTIFIC SOCIETIES.—Mr. Horton Bolitho has recently suggested that the Cornish scientific societies should pool their resources by means of amalgamation, or that, failing this, there should in future be greater co-operation by means of frequent conferences of the executives controlling the various organizations. We are much impressed with the advantages of such a scheme from the point of view of over-lapping, and also of increased research work. At present there are in existence the Royal Geological Society of Cornwall, the Royal Institution of Cornwall, and the Royal Cornwall Polytechnic Society. The transactions of each deal very largely—indeed principally—with geological, mineralogical, and mining problems, and while, doubtless, each of the societies would be loth to lose its separate identity, research work would distinctly benefit by amalgamation.

TIN FLOTATION PROCESS AT EAST POOL.—Most hopeful statements have recently been made by Mr. C. A. Moreing (of Messrs. Bewick, Moreing & Co., general managers of East Pool & Agar, Ltd.), and by Mr. M. T. Taylor, the superintendent of the mines, as to flotation of tin oxide in the uncalcined feed coming direct from the stamp batteries. The reagent used in this process is the discovery of Messrs. M. T. Taylor, the superintendent, and J. W. Partington, the chief chemist of the company, and they have applied for patents. The experimental plant which has been erected deals with 20 to 25 tons of ore per day and a recovery of 75 to 80% has been secured, which compares with 72 to 73% by ordinary concentration methods. In the laboratory, an extraction of 93% has been secured, and the difference is explained by Mr. Taylor as due to the fact that there is no re-treatment yet of the tails in the experimental unit. Mr. Taylor describes the process as follows: The ore passes from the mill, is lifted into dewaterers, the pulp then flowing into eight flotation boxes. A propeller is revolving at about a thousand revolutions. Air is admitted through a pipe ingeniously placed in front of the boxes which gives the desired subaeration. The reagent is admitted at various points along the boxes, at the points most advantageous. All metallic concentrates rise and float over the boxes into the concentrate launder, and then pass on to the concentrate bin. Then a burning process takes place for the removal of arsenic and sulphur, tin and wolfram being left for magnetic separation.

LETTER TO THE EDITOR

Spelling Reform.

The Editor:

Sir—Now that the Simplified Spelling Society is circulating a petition for a Royal Commission on spelling reform and is arranging for a conference to which American representatives are to be invited, your editorial in the May Magazine is of timely interest. But it does seem a pity that your conviction of the "absurdities, irregularities, and exceptions to rule" of our spelling did not lead you to adopt a few reformed spellings and thus show your practical sympathy with those scholars who are working for reform, instead of deciding to do nothing until a perfect spelling has been developed or a universal language adopted. The prejudice against spelling reform is so intense that even the slightest help is welcomed. Even if the universal language is adopted, English will still live. And, as has been pointed out by Dr. Collins in the *Scientific Monthly* for April, 1918, with a reformed spelling and some grammatical changes, English itself has an excellent chance of becoming a universal language; it is already spoken by more people and more widely distributed than any other European tongue. Its utility for commercial correspondence is appreciated by the Japanese steamship companies in San Francisco, for they use it in corresponding with their home offices in preference to Japanese.

No matter what happens, English is certain to be taught to many billions of children before it is replaced by anything more perfect. It is the welfare of these children for which the spelling reformers are working. At this very instant there must be something like 30,000,000 children who are having their respect for the intelligence of their ancestors diminisht and their reasoning powers demoralized by learning the inconsistencies of our spelling. Compared with German children ours take a year longer to learn to read and spell, a grievous handicap in this competitive age.

With use the weird appearance of the reformed spellings will pass away and our present spelling will appear weird. *Hav* now looks weird, but on reflection it seems plain that the requiring of every one to write the final "e" in *have* merely to remind us of the fact that some 500 years ago our ancestors used to pronounce the word in two syllables, is a weirder proceeding than to write *hav*, which represents the present pronunciation. The retention of "ugh" in such words as *though*, *through*, uselessly marks a vanisht gutteral and is equally weird.

Why not adopt some of the following words to show the sincerity of your belief that reform is needed? You might adopt: yu, wil, spel, wel, ar, iz, liv, giv. Mr. Sidni Bond has pointed out that these spellings are likely to be unchanged in any system of reformed spelling. If these words do not appeal to you you might try tho (though), thru (through), or sulfur and derivatives now used by the American Institute of Mining & Metallurgical Engineers, including catalog and program.

Many authors who believe in spelling reform are debarred from showing their belief by the rigid rules of editors. A professor of mineralogy has complained to me that American scientific journals will not follow his spelling. Why not allow authors, who so desire, to use reformed spellings that are already admitted into our larger dictionaries—the Standard, for example. In order to assist the editor and proofreader such spelling could be underscored in red ink. Spellings so markt have been printed in the *Bulletin* of the A.I.M.M.E. with no special damage as far as heard from.

Much information on spelling reform is to be found in the handbook of Simpler Spelling now being issued by the Simplified Spelling Board, of No. 1 Madison Avenue, New York; this will be sent free to all applicants. The Simplified Spelling Society, No. 44, Russel Street, London, W.C., has a large number of pamflets for free distribution.

W. H. SHOCKLEY.

Palo Alto, California,
September 17.

[Acting on Mr. Shockley's hint relating to the difficulty experienced by authors in inducing editors to adopt their spelling, we have relaxed our rules and have followed copy in reproducing this letter. Though considering it advisable at present to adhere to the Oxford Dictionary, we have no desire to stand in the way of spelling reformers.—EDITOR.]

PERSONAL

H. FOSTER BAIN'S address will be "care of Thomas Cook & Son, Rangoon," for the next three months.

CHARLES A. BANKS has left for British Columbia.

G. C. BARNARD has gone to Jalisco, Mexico.

W. J. BARNETT is back from South America.

DR. J. MACKINTOSH BELL has returned to practice as mining engineer and geologist and has opened an office in Lumsden Buildings, Toronto.

EDWARD W. BERRY and J. T. SINGEWALD, Jr., professors of geology in the Johns Hopkins University, have returned from a visit to Peru, Bolivia, and Chile.

A. E. BIDLAKE has left on his return to the Abbontiakoon mine, West Africa.

J. COGGIN BROWN is here from Burma.

J. W. COLLIS, who was for 2½ years with the London office of the Allis-Chalmers Manufacturing Co., has joined S. Thornley Mott & Vines, Ltd., British agents for the Marion Steam Shovel Co., of Ohio.

H. O. CREIGHTON has left for Nigeria.

THOMAS F. DONNELLY has left New York for a lengthy tour of mining districts in South America.

A. W. FREEMAN has returned to Sydney from the Federated Malay States.

B. L. GARD'NER left on December 3 for West Africa to take up an appointment with the Ashanti Goldfields Corporation.

D. GIBSON left for French West Africa on November 29.

C. M. HARRIS is leaving for Australia on the 20th inst.

JOHN HENDERSON has left for Ipoh, Perak.

SIR THOMAS H. HOLLAND has left for India.

H. C. HOOVER has accepted nomination to the presidency of the American Institute of Mining and Metallurgical Engineers.

J. UNDERWOOD JARVIS has left for French West Africa.

R. R. JEWELL has left for West Africa.

L. J. MAYREIS has left for India.

Dr. E. T. MELLOR is returning to the Rand.

F. P. MENNELL is engaged in exploration work at the Rhodesia Broken Hill lead-zinc mine.

FRANK MERRICKS has been nominated by Council for the presidency of the Institution of Mining and Metallurgy for the year 1920–21.

H. R. COPE MORGAN has left for Jos, Nigeria.

JOHN MORGAN has joined the board of the Colombian Mining & Exploration Company.

WILLIAM MOTHERWELL has returned to San Francisco from Mysore.

P. N. NISSEN left for Canada on December 6.

JOHN POPE left for South Africa on November 21.

SIR RICHARD REDMAYNE has resigned as Chief Inspector of Mines.

ROBERT H. RICHARDS has been joined in business by Professor Charles E. Locke. The firm will be known as Richards & Locke, and the offices will be at 69, Massachusetts Avenue, Cambridge, Mass

WILLIAM SPALDING is expected from Spain.

S. J. SPEAK is back from the United States.

E. GIBBON SPILSBURY has gone from New York to Brazil to study the question of establishing steel works in that country.

W. H. STENTIFORD has been elected president of the Chartered Institute of Secretaries.

F. O. STEPHENSON has returned to South Africa after demobilization, to resume his duties as local manager for Head, Wrightson & Co., Ltd.

A. B. WATSON has left for West Africa.

DAVID WILKINSON is to succeed C. D. Leslie as consulting engineer to the Consolidated Gold Fields.

ERNEST WILLIAMS has completed his work with the Mineral Resources Department, and is back at his office, 806, Salisbury House, London, E.C.2.

S. R. JAMESON, consulting engineer to the Sir Abe Bailey group, died at Salisbury, Rhodesia, early in October. He was a nephew of Dr. Jim and was born in Cape Province. Before joining Sir Abe Bailey, he was one of Sir George Farrar's engineers.

JOHN H. DARBY, of Brymbo, Wrexham, who died on October 26, was one of the leading iron metallurgists in Great Britain, being identified particularly with the development of the basic open-hearth steel process and the by-product coke-oven. For several years he was manager of the Broughton, Plas Power, and Brymbo collieries, and subsequently took up the management of the Brymbo Iron and Steel Works. In 1884 he introduced at these works the then new basic open-hearth process, and the process has been ever since successfully carried out there. He was the inventor of a method of re-carbonizing steel without spiegel or ferro-manganese, a process which was largely used for many years in the manufacture of rails and sections. In 1893 he installed a by-product coking plant on the Semet-Solvay system at the Brymbo works, this being the first of its kind to be worked in conjunction with iron and steel works in this country.

TRADE PARAGRAPHS

JOHN BROWNING, 146 Strand, London, W.C., has sent us a catalogue of petrological and other microscopes, and spectroscopes and spectrometers.

THE CLIMAX ROCK - DRILL & ENGINEERING WORKS, LTD., of Camborne, and 4 Broad Street Place, London, E.C., send us a pamphlet giving the latest details of their various drills.

THE WESTERN WHEELED SCRAPER CO., of Aurora, Illinois, U.S.A., send us a brochure on concrete road building. Their system and plant will be applicable to advantage at many mines.

ROBERT J. COOK & HAMMOND, of 47-49 Tothill Street, Westminster, are putting on the market the protractors invented by T. G. Bocking. These protractors will be found of use to the mine surveyor. They occupy much less room than the ordinary protractor without suffering in accuracy and detail.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO., LTD., of Cambridge, announce the absorption of the business of Robert W. Paul, of Cambridge and New Southgate, London. The name of the company is to be changed to the Cambridge and Paul Instrument Co., Ltd.

BRUCE PEEBLES & CO., LTD., of Edinburgh, send us their pamphlet 13C, which describes the firm's medium and low-speed alternators. This gives a full specification of the machines, together with lists of ratings for 50 and 25 cycle alternators for all pressures from 200 to 6,600 volts. A rule is given for working out the ratings of machines of other periodicities. The weights and dimensions are given in inches and hundredweights, and also in millimetres and kilograms.

THE METROPOLITAN-VICKERS ELECTRICAL CO., LTD., formerly the British Westinghouse Co., Ltd., of Trafford Park, Manchester, send us a number of pamphlets. One of these gives a complete description of their Rateau-type mixed pressure steam turbines, and another of static transformers for use with electric furnaces. Others deal with transformers for colliery plants, electric drives for tools, oil switches, voltage regulators, electric meters, etc.

GEORGE KENT, LTD., of 199/201 High Holbor London, W.C.1, send us a number of publications relating to the Venturi meter. Among recent installations is one at the Gopeng Consolidated. Here there are three 30 in. meters, with an automatic valve which controls the water supply of each of the three meters, so that each of the three mines supplied are able to regulate the supply of water to which they are entitled. The Venturi meter is also applied at many gold mines for measuring the flow of slime; the meter is never choked or clogged by solids in suspension.

THE BIRMINGHAM SMALL ARMS CO., LTD., of Birmingham, and the DAIMLER CO., LTD., of Coventry, have collaborated in producing a handsome book recording their war work. The book deals with the Lee-Enfield rifle, the Lewis gun, motor cycles, Daimler cars, aeroplanes and their engines, tractors, tanks, and shells. The compilation of the book has been in the hands of George H. Frost, and the printing has been done by Albert Frost & Sons, the printers of this Magazine, a firm which, as our readers are obviously aware, turn out excellent work.

W. H. DORMAN & CO., LTD., of Stafford, and 3 St. Bride's House, London, E.C.4, are now opening a campaign for the "Wave-Transmission" rock-drill and caulking tool, invented by George Constantinesco, of Bucharest, and developed by Walter Haddon, chairman and managing director of Dorman's. We gave an account of this drill in the issue of March, 1917. The application of "wave-transmission" to mining has been in abeyance during the last two or three years, as Messrs. Haddon and Constantinesco have been fully occupied in war work, in particular applying the principle to the timing of gun-fire between the blades of aeroplane propellers. We intend to give further information relating to the rock-drill in an early issue.

CHAS. BUTTERS & CO., LTD., of New York and London, have recently put on the market a new flotation machine, known as the JONES-BELMONT CELL, invented by A. H. Jones, of the Belmont group of mines, Nevada. The cell is constructed of cast-iron, sheet steel, or concrete as conditions may require. It combines the advantages of both mechanical and pneumatic agitation, and is so constructed that uniform circulation of pulp is assured at all points. The advantages of mechanical agitation are secured through introducing pulp between two cones of 60° slope, delivering to the bottom of a central barrel, having both impellers and baffles, which, in addition to emulsifying, also acts as a pump discharging pulp from the top of the barrel with a swirling motion over a circular fabric blanket. At the outer edge of this blanket, pulp is either returned between the two 60° cones over about nine-tenths of their periphery to the bottom of the impeller-barrel, discharged to the next cell, or run off as tailing. These operations are regulated by an automatic float-actuated valve, which ensures a number of complete circulations of pulp through the impeller-barrel and over the blanket in each cell before being discharged. By this means the sulphides are allowed every possible opportunity for emulsification and frothing, and complete circulation is ensured. Considered as a pneumatic machine, the device possesses many advantages. The pulp zone above the blanket has only a shallow depth, requiring low air-pressure to ensure satisfactory results and a short upward travel of sulphides to reach the froth zone. The delivery of pulp close to the blanket, and with considerable velocity across it, tends to turn over both gangue and sulphides many times during each passage, allowing every opportunity for the sulphide content to become disengaged from the gangue and join the froth. The decided swirl of the pulp over the blanket tends to carry the froth toward the periphery by centrifugal force, delivering it to a launder at the rim in a free, continuous flow. The machine does not require the use of surplus gathering oil to make and sustain the froth across the cell to the point of delivery, and so avoids difficulties in breaking down a heavy froth in the subsequent operations of thickening and dewatering. In actual use the machine has never developed any circulating difficulties in handling gangue that is ground fine enough to free its sulphide content for flotation; neither have the heavier sands accumulated on the blanket. A series of eight machines, handling hard quartz ground to pass 60-mesh, was closed down for twelve hours without any other precaution than shutting off the power and feed. On starting, no excess power was required to free the impeller, and the pulp was in perfect circulation in five minutes, the machines accomplishing a regular delivery of froth. All irregularities of feed are compensated by a float-actuated valve which ensures a constant pulp-level. Adjustment of the pulp-level and air can readily be made to suit changes in conditions. Five Jones-Belmont cells, four being roughers, and one a cleaner, handle from 200 to 500 tons per day, depending upon the character of ore, sulphide content, and dilution of pulp. Each cell requires a maximum of 2½ h.p. under full load. The normal air-consumption is 120 cu. ft. per cell per minute.

METAL MARKETS

COPPER.—This market has been rather quiet during the past month so far as actual business in refined metal is concerned. The consumption of course has been interfered with in America to a certain extent by the steel strike, but to a more important extent possibly by the coal strike, and no doubt by the general labour unrest there. On this side of the Atlantic the amount of copper going into actual consumption has been much reduced by the moulders' strike. Meanwhile the large producers in America have been steadily accumulating supplies owing to there being a very slow sale for their products. It now appears that in spite of the curtailed production, and much talk about the big consumption that was going on, the actual fact is that the surplus supplies were increasing. It is evident that the large selling interests have realized that they must cut down their selling prices. In view of the fact that the average cost of production in the United States is only a little over 16 cents per lb., and the large interests were endeavouring to obtain for their metal something like 23½ cents, no one will have great sympathy with them now that they have found it necessary to reduce. At the time of writing the price there has declined to about 18½ cents, and there is no sign of buyers coming forward on any important scale. As soon as a price level is reached which proves attractive to buyers it seems probable that a large business will be done, as there is no doubt that important quantities of copper are required in the world, and it then seems likely that an upward reaction will follow. So far as the standard market is concerned, business has only been moderately active, and latterly prices there have been depressed in sympathy with electrolytic.

Average price of cash standard copper: November 1919, £98. 19s. 9d: October 1919, £103 11s.; November 1918, £122. 5s.; October 1918, £122 5s.

TIN.—This market has as usual seen some varying fortunes during the period under review, but on the whole it can only be said that prices have been very well maintained in spite of sundry circumstances which might have been looked upon as discouraging. In the early part of the month the outbreak of the coal strike

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

COPPER

	Standard Cash	Standard (3 mos.)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
Nov.	£ s. d. £ s. d.	£ s. d. £ s. d	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
11	100 15 0 to 101 0 0	102 0 0 to 102 5 0	112 0 0 to 117 0 0	115 0 0 to 117 0 0	112 0 0 to 113 0 0
12	100 15 0 to 101 0 0	102 0 0 to 102 5 0	112 0 0 to 117 0 0	115 0 0 to 117 0 0	112 0 0 to 113 0 0
13	100 10 0 to 100 15 0	102 0 0 to 102 5 0	112 0 0 to 117 0 0	115 0 0 to 117 0 0	112 0 0 to 113 0 0
14	100 7 6 to 100 12 6	101 15 0 to 102 0 0	112 0 0 to 117 0 0	115 0 0 to 117 0 0	112 0 0 to 113 0 0
17	99 15 0 to 100 0 0	101 0 0 to 101 5 0	112 0 0 to 117 0 0	115 0 0 to 117 0 0	112 0 0 to 113 0 0
18	98 15 0 to 99 0 0	100 5 0 to 100 10 0	112 0 0 to 116 0 0	114 0 0 to 116 0 0	112 0 0 to 113 0 0
19	97 15 0 to 98 0 0	99 0 0 to 99 15 0	111 0 0 to 115 0 0	113 0 0 to 115 0 0	112 0 0 to 113 0 0
20	97 0 0 to 97 5 0	98 5 0 to 98 10 0	111 0 0 to 115 0 0	113 0 0 to 115 0 0	112 0 0 to 113 0 0
21	98 10 0 to 98 15 0	99 15 0 to 100 0 0	111 0 0 to 115 0 0	113 0 0 to 115 0 0	112 0 0 to 113 0 0
24	98 15 0 to 99 0 0	100 5 0 to 100 10 0	111 0 0 to 115 0 0	113 0 0 to 115 0 0	112 0 0 to 113 0 0
25	97 5 0 to 97 10 0	98 15 0 to 99 0 0	109 0 0 to 113 0 0	11[illegible] 0 0 to 113 0 0	109 0 0 to 110 0 0
26	95 10 0 to 95 15 0	97 0 0 to 97 5 0	109 0 0 to 11[illegible] 0 0	111 0 0 to 11[illegible] 0 0	109 0 0 to 110 0 0
27	94 10 0 to 94 15 0	96 5 0 to 96 10 0	107 0 0 to 109 0 0	107 0 0 to 109 0 0	109 0 0 to 110 0 0
28	95 5 0 to 95 10 0	96 15 0 to 97 0 0	106 0 0 to [illegible] 0 0	107 0 0 to 109 0 0	104 0 0 to 105 0 0
Dec.					
1	97 0 0 to 97 5 0	98 10 0 to 98 15 0	105 0 0 to 107 0 0	105 0 0 to 107 0 0	104 0 0 to 105 0
2	97 15 0 to 98 0 0	99 5 0 to 99 10 0	106 0 0 to 108 0 0	106 0 0 to 108 0 0	106 0 0 to 107 0 0
3	98 5 0 to 98 10 0	99 10 0 to 99 15 0	107 0 0 to 108 0 0	107 0 0 to 108 0 0	106 0 0 to 107 0 0
4	99 10 0 to 99 15 0	100 15 0 to 101 0 0	108 0 0 to 110 0 0	108 0 0 to 110 0 0	106 0 0 to 107 0 0
5	101 0 0 to 101 5 0	102 10 0 to 102 15 0	108 0 0 to 110 0 0	108 0 0 to 110 0 0	108 0 0 to 109 0 0
8	101 10 0 to 101 15 0	103 2 6 to 103 7 6	110 0 0 to 111 0 0	110 0 0 to 111 0 0	108 0 0 to 109 0 0
9	101 10 0 to 101 15 0	103 0 0 to 103 5 0	110 0 0 to 112 0 0	110 0 0 to 11[illegible] 0 0	109 0 0 to 111 0 0

in America was instrumental in somewhat depressing values on this side, in view of the assumption that the American demand would be considerably curtailed. Very soon, however, values recovered, and indeed America seems to have continued to take an interest in the market here during nearly the whole period of the labour trouble there. Of course the stoppage on that side allowed certain quantities of tin to accumulate which must now be used up, but in spite of that America has continued more or less steadily to buy here. In some quarters the view is taken that the United States has not bought much for delivery beyond January next, and a well-sustained demand is anticipated. Meanwhile a rather better inquiry has developed from the Continent, and some business is said to have been done with Germany. Values in the East have been pretty well maintained, although it is sometimes difficult to compare these with prices in the London market owing to the fact that the cable delays do not permit of London advices reaching the East until they are several days late. It seems possible that the heavy rise in silver will be instrumental in further keeping up costs of production in the East, and this may assist in preventing any material decline in values of this metal. Makers of English tin are well sold, and prompt delivery is comparatively scarce. The price of that description rules round about the same level as standard. There is no sign yet of China liquidating her supplies, while Batavia seems still to be very firm in her ideas of price.

Average price of cash standard tin: November 1919, £283. 13s. 7d.; October 1919, £279. 4s. 11d.; November 1918, £317. 7s. 7d.; October 1918, £335. 10s.

LEAD.—This market has seen a great deal of activity during the month of November, dealings on 'Change amounting to practically record proportions. There is no gainsaying the fact that much of the business done there is for speculative account, and for that reason the market may not be considered fundamentally sound, because re-selling is bound to appear sooner or later, when a reaction may possibly be seen. On the other hand, the future of supplies is uncertain and difficult to forecast. Spain seems to have little to spare for this country, and the same might be said of America, while the rates of exchange naturally militate against any cheap metal being procurable from the latter country. As regards Australia, a good deal depends of the strike situation. So far, the strike still goes on, although there seems to be a rather more hopeful feeling about in regard to it. As it is, however, the stocks in this country are diminishing, and speculators seem to have taken the view that higher prices were inevitable. To a certain extent they have assisted in bringing this event about, and at the moment no material decline seems probable, as even if the Australian strike were settled it would be some time before supplies would be available for shipment. Of course there are at the moment certain stocks in the country which are being gradually brought here. The demand from consumers here has been very good, partly from the electrical trade, and quite a good demand has also been seen for export.

Average price of soft pig lead: November 1919, £34. 16s. 1d.; October 1919, £28. 15s. 11d.; November 1918, £31. 12s. 4d; October 1918, £29.

SPELTER.—This market has also seen a good deal of activity during the past month, and dealings on 'Change have been at times quite important, while prices have generally been firm. A satisfactory trade has been done with galvanizers for both prompt and forward delivery, but so far as can be ascertained the consuming trades do not seem to be entirely covered and will still have to make further purchases for delivery during the first quarter of next year. Should the opposite prove to be the case, it may mean that speculative re-sales would be instrumental in affecting values, but up to the present such liquidations have been very well absorbed, and whatever may happen in the market here there seems no doubt that this country must remain, for a time at least, dependent on America for supplies. Meanwhile the demand for the metal in that country seems anything but good, owing to the steel strike. On the other hand, the cost of production there is not very much below the present selling price, so that a material decline in values there can hardly be expected, while the adverse rate of exchange makes the parity of American values here actually above prices which have been ruling on the Metal Exchange, although from time to time the fluctuations of the two markets of course make it possible to buy in America

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			Nov.
33 15 0 to 34 2 6	34 15 0	46 5 0 to 46 15 0	278 10 0 to 278 15 0	279 0 0 to 279 5 0	68⅞	66¾	11
34 12 6 to 34 15 0	35 10 0	47 10 0 to 48 5 0	281 15 0 to 282 0 0	282 15 0 to 283 0 0	69	66¾	12
34 10 0 to 34 15 0	35 10 0	47 15 0 to 48 5 0	281 15 0 to 282 0 0	283 5 0 to 283 10 0	69	66⅛	13
34 7 6 to 34 12 6	35 10 0	47 15 0 to 48 0 0	283 10 0 to 283 15 0	284 12 6 to 284 17 6	68	65½	14
34 5 0 to 34 10 0	35 10 0	47 5 0 to 47 15 0	283 15 0 to 284 0 0	284 15 0 to 285 0 0	69	67	17
34 7 6 to 34 5 0	35 0 0	47 0 0 to 47 10 0	283 5 0 to 283 10 0	284 5 0 to 284 10 0	70	68⅛	18
34 10 0 to 34 7 6	35 10 0	46 15 0 to 47 5 0	282 10 0 to 282 15 0	284 0 0 to 284 5 0	70½	68½	19
35 12 6 to 35 12 6	36 10 0	46 15 0 to 47 5 0	283 0 0 to 285 5 0	284 15 0 to 285 0 0	71¼	69¼	20
36 7 6 to 36 7 6	37 5 0	47 0 0 to 47 10 0	284 15 0 to 285 5 0	286 5 0 to 286 10 0	73½	71¾	21
37 0 0 to 37 0 0	37 15 0	47 10 0 to 48 0 0	288 15 0 to 289 0 0	290 0 0 to 290 15 0	75½	73½	24
36 12 6 to 36 15 6	37 15 0	48 0 0 to 48 10 0	292 10 0 to 292 15 0	294 0 0 to 294 5 0	76	73⅜	25
36 7 6 to 36 10 0	37 10 0	48 0 0 to 48 10 0	295 5 0 to 295 10 0	296 15 0 to 297 0 0	75¾	73	26
36 17 6 to 36 15 0	37 15 0	48 0 0 to 48 10 0	295 10 0 to 295 15 0	296 15 0 to 297 0 0	74	71¾	27
37 10 0 to 37 12 6	38 10 0	48 5 0 to 48 15 0	296 0 0 to 296 5 0	297 10 0 to 297 15 0	72¾	71⅜	28
							Dec.
38 0 0 to 38 5 0	39 0 0	48 17 6 to 49 7 6	295 0 0 to 295 5 0	295 15 0 to 297 0 0	73⅛	72⅛	1
39 5 0 to 39 7 6	40 0 0	49 7 6 to 50 0 0	294 15 0 to 295 0 0	296 0 0 to 296 5 0	[illegible]	72¾	2
39 7 6 to 39 7 6	40 5 0	50 10 0 to 51 5 0	294 10 0 to 294 15 0	296 5 0 to 296 10 0	74¾	73¾	3
39 12 6 to 39 15 0	40 10 0	51 0 0 to 51 10 0	296 15 0 to 297 0 0	298 5 0 to 298 10 0	75	73¼	4
40 2 6 to 40 5 0	41 0 0	51 15 0 to 52 5 0	298 10 0 to 298 15 0	300 0 0 to 300 5 0	74	72¼	5
40 10 0 to 40 12 6	41 10 0	53 7 6 to 53 17 6	304 5 0 to 304 10 0	305 10 0 to 305 15 0	75¼	74⅛	8
40 10 0 to 40 15 0	41 10 0	53 10 0 to 54 5 0	308 5 0 to 308 10 0	309 10 0 to 309 15 0	75	73⅜	9

and sell here at a profit. There is no decision yet in regard to the question of smelting in this country. The period during which works received a subsidy expired early in November, and while they are understood to be working up existing stocks in this country, no decision has been announced as to the future policy of smelting here, and as to the disposal of the Australian zinc concentrates. Presumably this may be expected before long. A little spelter has come in here from Belgium and also from Germany. There does not seem to be any pressure of offers from the latter country, and it does not look as if this country can expect to get supplies to any extent from Germany in the immediate future.

Average price of spelter: November 1919, £46. 17s. 3d.; October 1919, £43. 18s.; November 1918, £52. 7s. 7d.; October 1918, £52.

ZINC DUST.—Prompt supplies have been none too plentiful, and prices have been firm. Australian high-grade (88 to 92% metallic zinc) has been steady at £75 per ton c.i.f. U.K.

ANTIMONY.—The market has been steady, the price of English regulus keeping at £47. 10s. per ton. Business has been reported in foreign at £44 c.i.f. U.K. for arrival early in 1920.

ARSENIC.—This market has been firm and the price stands about £65 to £67 for white delivered London.

BISMUTH.—12s. 6d. per lb. nominal.

CADMIUM.—6s. 3d. per lb.

ALUMINIUM.—£150 per ton for the home trade. It is reported that representatives of an American aluminium concern recently arrived in Japan to discuss with certain interests there as to the formation of a company of which the Americans would hold half the shares, and the Japanese the remainder. It appears that negotiations are being conducted with the Japanese Government as to water-power rights.

NICKEL.—Higher at £215 for the home trade and £220 for export.

COBALT METAL.—10s. 6d. per lb.

COBALT OXIDE.—7s. to 8s. per lb.

PLATINUM.—510s. per oz. nominal.

PALLADIUM.—500s. per oz. nominal.

QUICKSILVER.—Firmer at £23. 10s. per bottle.

SELENIUM.—12s. to 15s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER.—£41 to £43 per ton.

MANGANESE ORE.—Firm at 2s. 3d. per unit c.i.f. U.K. for Indian.

TUNGSTEN ORES.—Wolframite (65%) and scheelite (65%) 32s. 6d. per unit.

MOLYBDENITE.—85%, 75s. to 80s. per unit.

SILVER.—This market has been extraordinarily strong owing to the shortage of supplies and active buying, chiefly on the part of China. The price of standard bars touched the record high level of 76d. on November 25. At the end of that month the price stood at 72⅝d. for spot bars, the market having eased off on the announcement that the American Government had decided to release silver dollars for shipment. It has since firmed up again, however.

CORUNDUM.—No quotation.

GRAPHITE.—80%, £35 to £40 c.i.f. U.K.

CHROME ORES.—48–50% Cr_2O_3, about £8 per ton.

IRON & STEEL.—As in the past, one of the chief features in the Cleveland pig-iron market has been the shortage of foundry grades. Forge iron was of course more or less plentiful, while as regards hematite, business moved fairly freely. The moulders' strike has continued to drag on, and although it is to be hoped an early settlement will be arrived at, there is at present no particularly bright prospect of it in sight. Perhaps the most favourable sign is that the moulders in Scotland who were to have come out on strike on November 26 changed their minds and have remained at work. An interesting point in regard to the situation is that pig iron may now be exported without the necessity of procuring a licence. Unfortunately the inquiry from abroad is mostly for foundry iron, and there is practically none available for shipment after home requirements are met. In regard to manufactured iron and steel, business continues to be very active. An enormous inquiry is met with both for home and overseas markets, but works are already so very fully booked that much of the business cannot be placed. Fortunately the bricklayers' strike which stopped certain operations at steel works in Scotland is now over, but some large steel works in the North of England have been forced to close owing to the shortage of railway wagons.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Par Value
	Oz.	Oz.	Oz.	£
July, 1918	716 010	20,189	736,199	3,127,174
August	719,849	20,361	740,210	3,144,211
September	686,963	21,243	708,206	3,008,267
October	667,955	11,809	679,764	2,887,455
November	640,797	17,904	658,701	2,797,983
December	630,505	10,740	641,245	2,723,836
Year 1918	8,197,959	221,734	8,419,693	35,768,688
January, 1919	662,205	13,854	676,059	2,871,718
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,8[illegible]7	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,1[illegible]9	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1918	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	196,294
September 30	179,399	12,108	4,889	196,395
October 31	173 153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637
January 31, 1919	160,599	11,848	3,539	175,986
February 28	172,359	11,868	4,264	188,491
March 31	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,39[illegible]	5,294	186,806
October 31	167,499	12,691	4,492	184,682

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d	s. d.	£
July, 1918	2,167,869	27 10	21 2	6 6	702,360
August	2,158,431	28 1	21 7	6 3	676,146
September	2,060,635	28 2	22 0	5 10	600,330
October	2,015,144	28 0	22 5	5 3	531,774
November	1,899,925	28 5	23 1	5 1	480,102
December	1,855,691	28 7	23 0	5 6	507,860
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129
January, 1919	1,942,329	28 9	23 0	5 8	547,793
February	1,816,352	28 9	23 2	5 6	498,204
March	2,082,469	28 2	22 6	5 6	573,582
April	1,993,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715
June	2 032 169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1918	1919	1918	1919
	£	£	£	£
January	253,807	211,917	107,863	104,063
February	232,023	220,885	112,865	112,616
March	230,023	225,808	112,605	112,543
April	239,916	213,160	117,520	109,570
May	239,205	218,057	126,290	100,827
June	225,447	214,215	120,273	106,612
July	251,740	214,919	117,581	102,467
August	257,096	207 339	120,526	103,112
September	247,885	223,719	115,152	100,401
October	136,780	204,184	61,461	91,352
November	145,460	—	108,796	—
December	192,870	—	112,621	—
Total	2,652,250	2,154,203	1,333,553	1,043,563

Transvaal Gold Outputs.

	October, 1919	
	Treated	Value
	Tons	£
Aurora West	12,350	13,131
Bantjes	—	—
Barrett	—	—
Brakpan	42,000	78,876
City & Suburban	23,648	32,582
City Deep	60,000	108,998
Cons. Langlaagte	42,400	53,405
Cons. Main Reef	46,100	73,232
Crown Mines	182,000	248,928
Durban Roodepoort Deep	21,900	29,951
East Rand P.M.	134,000	159,288
Ferreira Deep	33,400	45,447
Geduld	44,600	67,192
Geldenhuis Deep	45,400	52,617
Ginsberg	—	—
Glynn's Lydenburg	3,112	5,517
Goch	14,400	12,658
Government G.M. Areas	126,000	217,826
Heriot	11,000	15,052
Jupiter	26,300	31,[illegible]98
Kleinfontein	51,000	71,823
Knights Central	23,000	30,865
Knights Deep	84,900	67,080
Langlaagte Estate	38,520	47,347
Luipaard's Vlei	18,230	750
Meyer & Charlton	14,700	41,188
Modderfontein	78,000	169,263
Modderfontein B	59,000	125,501
Modderfontein Deep	44,400	98 239
New Unified	11,500	11,9[illegible]0
Nourse	40,200	50,809
Primrose	17,100	17,581
Princess Estate	20,000	26,776
Randfontein Central	150,000	177,641
Robinson	43,700	42,771
Robinson Deep	57 300	81,308
Roodepoort United	23,500	24,841
Rose Deep	52,000	64,164
Simmer & Jack	51,200	57,529
Simmer Deep	50 800	53,669
Springs	39,600	77,044
Sub Nigel	9,700	26,158
Transvaal G.M. Estates	15,890	25,963
Van Ryn	32,100	32,532
Van Ryn Deep	50,700	113,[illegible]78
Village Deep	48,500	69,203
Village Main Reef	18,800	23,825
West Rand Consolidated	32,000	38,639
Witwatersrand (Knights)	34,350	39,232
Witwatersrand Deep	28,400	33 045
Wolhuter	29,700	36,230

West African Gold Outputs.

	October, 1919	
	Treated	Value
	Tons	£
Abbontiakoon	8,0[illegible]0	17,797
Abosso	7,404	12,735
Ashanti Goldfields	6,229	22,914
Offin River	—	188
Prestea Block A	15,390	23,745
Taquah	4,551	12,259
Wassau	—	—

Rhodesian Gold Outputs.

	October, 1919	
	Treated	Value
	Tons	£
Antelope	—	—
Cam & Motor	—	—
Eldorado Banket	—	30,724
Falcon	14,753	24,978*
Gaika	3,155	5,615
Globe & Phœnix	5,016	5 398†
Lonely Reef	4,600	26 131
Rezende	4,700	11,053
Rhodesia, Ltd.	945	1,545
Shamva	49,046	34,310
Transvaal & Rhodesian	1,800	4,600
Wanderer	—	—

* Gold, Silver and Copper; † Ounces Gold.

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
November, 1918	1,444	70,711	72,155	306,494
December	2,739	61,314	64,053	272,208
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	*nil*	66,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316 862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535

* By direction of the Federal Government the export figures were not published. † Figures not received.

Australian Gold Returns.—Par Values.

	Victoria.		Queensland.		New South Wales	
	1918	1919	1918	1919	1918	1919
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	25,000	18,000
February	58,113	46,955	45,470	43,330	28,000	24,000
March	65,412	40,267	48,020	48,000	30,000	16,000
April	29,620	63,818	47,600	61,200	30,000	24,000
May	87,885	37,456	46,740	38,200	45,000	16,000
June	45,765	41,465	51,420	44,600	32,000	17,000
July	64,347	37,395	51,000	42,060	25,000	22,000
August	61,163	51,564	44,600	49,700	21,000	20,000
September	65,751	—	45,900	37,120	32,000	13,000
October	*	—	54,400	36,100	40,000	28,000
November	*	—	38,200	—	25,000	—
December	70,674	—	56,281	—	38,000	—
Total	674,655	355,856	578,213	437,410	370,000	198,000

* Figures not received.

Australasian Gold Outputs.

	October, 1919	
	Treated	Value
	Tons	£
Associated	5,748	8,570
Associated Northern Blocks — Iron Duke	—	1,228*
Associated Northern Blocks — Victorious	—	363*
Blackwater	2,349	4,646
Bullfinch	5,800	6,018
Golden Horseshoe	12,408	24,567
Great Boulder Prop.	11,545	33,524
Ivanhoe	15,357	29,831
Kalgurli	3,611	8,523
Lake View & Star	10,287	11,947
Mount Boppy	—	—
Oroya Links	1,241	8,690†
Progress	1,300	1,539
Sons of Gwalia	13,426	18,826
South Kalgurli	6,970	11,322
Talisman	—	—
Waihi	15,226	24,068‡
Waihi Grand Junction	5,190	7,316‡

* Surplus; † Total receipts; ‡ Gold and Silver to October 4.

Miscellaneous Gold Output.

	October, 1919	
	Treated	Value
	Tons	£
Barramia (Sudan)	—	—
Esperanza (Mexico)	21,721	1,527††
Frontino & Bolivia (Colombia)	—	8,917
Nechi (Colombia)	105,258*	31,304†
Ouro Preto (Brazil)	7,500	12,990
Pato (Colombia)	32,124*	33,914†
Philippine Dredges (Philippine Islands)	—	—
Plymouth Cons. (California)	9,300	11,667
St. John del Rey (Brazil)	—	40,000
Santa Gertrudis (Mexico)	30,800	36,870††
Sudan Gold Field (Sudan)	—	—

* Cubic yards. † Dollars. †† Profit, gold and silver.

Production of Gold in India.

	1916	1917	1918	1919
	£	£	£	£
January	192,150	190,047	176,030	162,270
February	183,264	180,904	173,343	153,775
March	186,475	189,618	177,950	162,790
April	192,208	185,835	176,486	162,550
May	193,604	184,874	173,775	164,080
June	192,469	182,426	174,375	162,996
July	191,404	179,660	171,950	163,795
August	192,784	181,005	172,105	[illegible]
September	192,330	183,630	170,360	156,450
October	191,502	182,924	167,740	157,750
November	192,298	182,388	157,176	—
December	205,164	190,852	170,630	—
Total	2,305,652	2,214,163	2,061,920	1,509,296

Indian Gold Outputs.

	October, 1919	
	Tons Treated	Fine Ounces
Balaghat	3,350	2,052
Champion Reef	11,212	6,725
Hutti (Nizam's)	—	750
Jibutil	—	—
Mysore	20,585	12,554
North Anantapur	800	1,076
Nundydroog	8,642	6,464
Ooregum	12,900	7,517

Base Metal Outputs

		October 1919
Arizona Copper	Short tons copper	1,450
British Broken Hill	Tons lead concentrate	—
	Tons zinc concentrate	—
	Tons carbonate ore	—
Broken Hill Block 10	Tons lead concentrate	—
	Tons zinc concentrate	—
Burma Corp.	Tons refined lead	1,400
	Oz. refined silver	149,560
Cordoba Copper		—
Fremantle Trading	Long tons lead	—
North Broken Hill	Tons lead	—
	Oz. silver	—
Poderosa	Tons copper ore	380
Rhodesian Broken Hill	Tons lead and zinc	771
Tanganyika	Long tons copper	2,230
Tolima	Tons silver-lead concentrate	55
Zinc Corp.	Tons zinc concentrate	—
	Tons lead concentrate	—

Imports of Ores, Metals, etc., into United Kingdom.

		Nov. 1919	Year 1919
Iron Ore	Tons	342,563	4,835,751
Manganese Ore	Tons	13,220	255,315
Copper and Iron Pyrites	Tons	33,323	311,752
Copper Ore	Tons	1,070	12,424
Copper Matte and Precipitate	Tons	1,928	13,603
Copper Metal	Tons	7,668	106,583
Tin Concentrate	Tons	2,844	33,242
Tin Metal	Tons	2,195	21,523
Lead, Pig and Sheet	Tons	2,679	205,114
Zinc (Spelter)	Tons	8,099	87,895
Quicksilver	Lb.	—	2,608,719
Zinc Oxide	Cwt.	6 096	[illegible]
White Lead	Cwt.	12,568	116,028
Barytes	Cwt.	23,578	378,439
Phosphate	Tons	18,567	308,672
Brimstone	Cwt.	9,947	137,978
Boracic Compounds	Cwt.	18,768	274,151
Petroleum:			
Crude	Gallons	—	7,577,549
Lamp Oils	Gallons	8,916,395	143,009,603
Motor Spirit	Gallons	11,589,012	187,364,041
Lubricating Oils	Gallons	[illegible]	57,828,998
Gas Oil	Gallons	[illegible]	[illegible]
Fuel Oil	Gallons	[illegible]	240,900,456
Total Petroleum	Gallons	[illegible]	[illegible]

United States Metal Exports and Imports.

Exports.	June Tons.	July Tons.	Imports.	June Tons.	July Tons.
Copper Ingots	10,826	18,917	Antimony......	722	645
Copper Tubes	248	149	Tin Con.	—	1,975
Copper Sheets	229	195	Tin	50	897
Copper Wire..	2,127	2,468	Manganese Ore	31,550	15,585
Lead, Pig......	7,492	2,367	TungstenCon	338	452
Zinc	10,730	8,842	Pyrites	50.545	63.088
Zinc Sheets ...	746	896			

Outputs of Tin Mining Companies.
In Tons of Concentrate.

	Year 1918 Tons	Oct. 1919 Tons	Year 1919 Tons
Nigeria:			
Abu	33	-	16
Anglo-Continental	207	-	117
Associated Nigerian	—	40	120
Benue	146	4	63
Berrida	—	-	1
Bisichi	275	27	168
Bongwelli	17	3	46
Dua	60	5	56
Ex-Lands	342	30	200
Filani	37	5	25
Forum River	274	18	143
Gold Coast Consolidated	30	2	29
Gurum River	99	10	91
Jantar	141	10	91
Jos	228	14	173
Kaduna	178	14	155
Kaduna Prospectors	—	11	58
Kano	60	12	126
Kassa-Ropp	133	-	84
Keffi	118	-	30
Kuru	12	22	231
Kuskie	21	3	7
Kwall	108	31	38
Lower Bisichi	99	4	64
Lucky Chance	27	2	25
Minna	40	6	36
Mongu	476	45	447
Naraguta	478	51	353
Naraguta Extended	280	30	229
New Lafon	198	-	125
Nigerian Tin	87	-	25
Ninghi	—	6	46
N.N. Bauchi	435	42	324
Offin River	120	6	50
Rayfield	689	45	533
Ropp	836	100	884
Rukuba	132	6	41
South Bukeru	94	6	44
Sybu	40	2	25
Tin Areas	96	8	65
Tin Fields	108	8	137
Toro	17	-	3
Union & Rhodesian Trust	—	-	6
Federated Malay States:			
Chenderiang	179	-	197
Gopeng	979	57	665
Idris Hydraulic	136	24	187
Ipoh	245	14	135
Kamunting	236		168
Kinta	478	42	372
Kledang	28	-	10
Labat	399	45	373
Malayan Tin	730	47	528
Pahang	1,877	183	1,809
Rambutan	207	18	138
Sungei Besi	408	37	332
Tekka	508	42	377
Tekka-Taiping	400	23	266
Tronoh	1,364	121	1,228
Tronoh South	133	-	-
Cornwall:			
Cornwall Tailings	140	-	-
Dolcoath	787	-	554
East Pool	1,336	83	833
Geevor	392	-	186
South Crofty	598	50	476
Other Countries:			
Aramayo Francke (Bolivia)	1,816	172	1,931
Briseis (Tasmania)	327	11	183
Deebook (Siam)	398	32	242
Mawchi (Burma)	658	46	618
Porco (Bolivia)	227	23	232
Renong (Siam)	615	62	703
Rooiberg Minerals (Transvaal)	335	13	222
Siamese Tin (Siam)	989	95	551
Tongkah Harbour (Siam)	1,528	124	1,005
Zaaiplaats (Transvaal)	563	13	248

Nigerian Tin Production.

In long tons of concentrate of unspecified content.
Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1914	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons	Tons
January	485	417	531	667	678	613
February	469	358	528	646	668	623
March	502	418	547	655	707	606
April	482	444	486	555	584	546
May	480	357	536	509	525	483
June	460	373	510	473	492	484
July	432	455	506	479	545	481
August	228	438	498	551	571	616
September	289	442	535	538	520	561
October	272	511	584	578	491	625
November	283	467	679	621	472	—
December	326	533	654	655	518	—
Total	4,708	5,213	6 594	6.927	6,771	5.638

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
July 1	170½	£34,035	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	146¼	£33,816	£231 4 6
August 12	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	142½	£28,793	£202 1 2
September 24	145¾	£29,639	£203 7 2
October 7	136½	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	141¼	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	166¾	£25,170	£150 19 0
December 16	175½	£26,032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918	4,094	£786.541	£192 0 0
January 13, 1919	160	£20,888	£130 11 0
January 27	135½	£17,000	£125 10 7
February 10	153	£17,441	£113 19 10
February 24	142	£15,015	£105 14 10
March 10	144½	£18,123	£125 8 5
March 24	148½	£17 877	£120 7 8
April 7	134½	£15,258	£111 8 10
April 22	134¼	£15,023	£111 18 1
May 5	129	£14,919	£115 13 2
May 19	126½	£15,844	£125 5 0
June 2	140	£17,185	£122 15 0
June 16	139	£17.206	£123 15 9
June 30	136	£16,782	£123 8 0
July 14	145	£18.250	£125 17 3
July 28	122	£16.939	£138 16 11
August 11	127½	£17,125	£134 6 5
August 25	130½	£18,297	£140 4 3
September 8	115½	£16.588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3

Details of Redruth Tin Ticketings.

	Nov. 3	Nov. 17	Dec. 1	
	Tons Sold	Tons Sold	Tons Sold	Realized per ton
				£ s d.
Grenville Utd., No. 1	7	7	6	156 7 6
" " No. 1a	6	7	6	156 2 6
" " No 2	2	—	2	58 15 0
Tincroft Mines, No. 1	5½	5	5	171 7 6
" " No. 1a	6	6	6	172 0 0
Levant Mines	—	14	—	—
Hingston, etc.	8	—	—	—
Penryn Min'l No. 1	—	—	6	155 10 0
" " No. 1a	-	—	6	156 15 0
Trencrom	—	—	1	150 17 6
Total	34½	39	38	

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons. * Figures not published.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January ...	4,395	4,316	3,558	3,149	3,765
February ...	3,780	3,372	2,755	3,191	2,673
March	3,653	3,696	3,286	2,608	2,819
April	3,619	3,177	3,251	3,308	2,855
May	3,823	3,729	3,413	3,332	3,404
June	4,048	3,435	3,489	2,950	2,873
July	3,544	3,517	3,253	3,373	3,756
August	4,046	3,732	3,413	3,259	2,955
September .	3,932	3,636	3,154	3,166	3,161
October......	3,797	3,681	3,436	2,870	3,221
November .	4,059	3,635	3,300	3,131	2,972
December .	4,071	3,945	3,525	3,023	—
	46,767	43,871	39,833	37,370	34,454

STOCKS OF TIN

Reported by A. Strauss & Co. Long Tons.

	Oct. 31, 1919	Nov. 30, 1919
	Tons	Tons
Straits and Australian Spot	2,515	1,658
Ditto, Landing and in Transit............	1,235	805
Other Standard, Spot and Landing ...	1,900	1,537
Straits, Afloat..................................	1,390	1,310
Australian, Afloat............................	178	298
Banca, in Holland...........................	1,000	1,899
Ditto, Afloat	775	395
Billiton, Spot	—	—
Billiton, Afloat	49	—
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	276	225
Total Afloat for United States............	5,929	6,503
Stock in America	7,560	4,955
Total	22,807	19,585

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.

Reported by A. Strauss & Co. Long tons.

	Oct. 1919	Nov. 1919
	Tons	Tons
Shipments from:		
Straits to U.K.	1,060	620
Straits to America	3,070	3,290
Straits to Continent........................	301	225
Straits to Other Places	341	75
Australia to U.K.	250	250
U.K. to America	1,479	891
Imports of Bolivian Tin into Europe...	1,819	2,414
Supply:		
Straits	4,431	4,135
Australian	250	250
Billiton	—	—
Banca	1,950	—
Standard	1,267	395
Consumption:		
U K. Deliveries...............................	1,650	2,122
Dutch ,, ...	1,137	656
American ,, ...	2,875	6,665
Straits, Banca & Billiton, Continental Ports, etc.	375	509
Straits in hands of Malay Government	—	—
,, controlled by U.S. Government	—	—
,, ,, ,, French and Italian Governments.............................	—	—
Banca in Trading Company's hands...	—	—

PRICES OF CHEMICALS. December 8.

		£	s.	d.
Alum	per ton	16	10	0
Alumina, Sulphate of	,,	16	10	0
Ammonia, Anhydrous...............	per lb.		2	0
,, 0·880 solution	per ton	33	0	0
,, Carbonate	per lb.			7½
,, Chloride of, grey......	per ton	47	0	0
,, ,, ,, pure......	per cwt.	4	0	0
,, Nitrate of	per ton	60	0	0
,, Phosphate of............	,,	110	0	0
,, Sulphate of	,,	19	0	0
Antimony Sulphide	per lb.		1	3
Arsenic, White........................	per ton	65	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	55	0	0
Bleaching Powder, 35% Cl.	,,	17	0	0
Borax	,,	39	0	0
Copper, Sulphate of	,,	41	0	0
Cyanide of Sodium, 100%.........	per lb.			11
Hydrofluoric Acid	,,			7
Iodine..	,,		16	0
Iron, Sulphate of.....................	per ton	4	10	0
Lead, Acetate of, white	,,	83	0	0
,, Nitrate of	,,	56	0	0
,, Oxide of, Litharge	,,	50	0	0
,, White	,,	52	0	0
Lime, Acetate, brown.............	,,	14	0	0
,, ,, grey 80%...........	,,	20	0	0
Magnesite, Calcined	,,	36	0	0
Magnesium Chloride	,,	16	0	0
,, Sulphate...............	,,	12	0	0
Methylated Spirit 64° Industrial	per gal.		5	7
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	,,		1	6
,, Carbonate	per ton	100	0	0
,, Chlorate	per lb.		1	0
,, Chloride 80%	per ton	25	0	0
,, Hydrate (Caustic) 90%	,,	105	0	0
,, Nitrate.....................	,,	55	0	0
,, Permanganate	per lb		3	3
,, Prussiate, Yellow	,,		2	1
,, Sulphate, 90%	per ton	25	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	49	0	0
,, Arsenate 45%..............	,,	45	0	0
,, Bicarbonate	,,	8	10	0
,, Bichromate	per lb.			11
,, Carbonate (Soda Ash)...	per ton	12	10	0
,, ,, (Crystals) ...	,,	5	10	0
,, Chlorate.....................	per lb.			6
,, Hydrate, 76%	per ton	24	0	0
,, Hyposulphite	,,	19	0	0
,, Nitrate, 95%...............	,,	21	0	0
,, Phosphate	,,	28	0	0
,, Prussiate......................	per lb.		1	0
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)......	,,	3	10	0
,, ,, (Glauber's Salts)	,,	4	0	0
,, Sulphide.....................	,,	25	0	0
Sulphur, Roll..........................	,,	23	0	0
,, Flowers......................	,,	23	0	0
Sulphuric Acid, Non-Arsenical... 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%...	,,	5	0	0
Tartaric Acid..........................	per lb.		3	2
Zinc Chloride	per ton	23	0	0
Zinc Sulphate	,,	21	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Dec. 6 1918 £	s.	d.	Dec. 5 1919 £	s.	d.
RAND:						
Brakpan	3	15	0	3	17	6
Central Mining (£8)	7	17	6	11	10	0
City & Suburban (£4)		17	0		9	0
City Deep	2	17	0	3	5	0
Consolidated Gold Fields	1	17	6	3	1	3
Consolidated Langlaagte	1	1	3	1	6	3
Consolidated Main Reef		17	0		14	9
Consolidated Mines Selection (10s.)	1	6	6	1	13	6
Crown Mines (10s.)	2	10	0	3	12	6
Daggafontein	1	4	6	1	3	3
Durban Roodepoort Deep		10	0		10	0
East Rand Proprietary		5	3		11	6
Ferreira Deep		15	0		12	6
Geduld	1	15	0	3	2	6
Geldenhuis Deep		13	9		13	9
Gov't Gold Mining Areas	4	12	0	5	5	0
Heriot	1	2	0		12	0
Johannesburg Consolidated	1	3	0	1	12	6
Jupiter		5	6		8	0
Kleinfontein		15	6		15	0
Knight Central		5	6		7	6
Knights Deep		9	6		10	9
Langlaagte Estate		19	6	1	0	6
Meyer & Charlton	4	16	3	4	15	0
Modderfontein (£4)	26	2	6	32	0	0
Modderfontein B	8	0	0	9	5	0
Modder Deep (5s.)	7	12	6	2	12	6*
Modder East		—		1	11	3
Nourse		17	6		15	6
Rand Mines (5s.)	3	8	0	3	15	0
Rand Selection Corporation	4	5	0	5	7	6
Randfontein Central		13	3		19	6
Robinson (£5)		16	0		14	0
Robinson Deep A (1s.)		18	0	1	3	9
Rose Deep		18	9	1	3	0
Simmer & Jack		6	6		7	3
Simmer Deep		3	6		3	0
Springs	3	8	9	3	1	3
Sub-Nigel	1	14	6	1	1	3
Union Corporation (12s. 6d.)		16	0	1	4	3
Van Ryn	1	0	0	1	2	6
Van Ryn Deep	3	8	9	5	0	0
Village Deep	1	0	0		17	9
Village Main Reef		15	0		9	6
Witwatersrand (Knight's)	1	7	6	1	2	6
Witwatersrand Deep		14	0		11	6
Wolhuter		5	6		5	6
OTHER TRANSVAAL GOLD MINES:						
Glynn's Lydenburg	1	2	6		16	3
Sheba (5s.)		1	3		2	0
Transvaal Gold Mining Estates		16	6		15	0
DIAMONDS IN SOUTH AFRICA:						
De Beers Deferred (£2 10s.)	16	0	0	30	0	0
Jagersfontein	4	7	6	7	5	0
Premier Deferred (2s. 6d.)	6	17	6	13	10	0
RHODESIA:						
Cam & Motor		9	0		10	0
Chartered British South Africa	1	3	6	1	1	6
Eldorado		6	9		5	6
Falcon	1	0	3		14	3
Gaika		15	9		16	6
Giant		8	0		8	6
Globe & Phœnix (5s.)	1	8	0		17	6
Lonely Reef	1	17	6	3	2	6
Rezende	4	12	6	4	12	6
Shamva	1	15	0	2	2	6
Willoughby's (10s.)		7	0		6	6
WEST AFRICA:						
Abbontiakoon (10s.)		5	0		3	9
Abosso		7	3		13	9
Ashanti (4s.)	1	0	6	1	5	0
Prestea Block A		4	0		5	6
Taquah		14	6		16	3
WEST AUSTRALIA:						
Associated Gold Mines		3	6		4	0
Associated Northern Blocks		4	3		3	6
Bullfinch		1	9		3	6
Golden Horse-Shoe (£5)	1	16	3	1	6	3
Great Boulder Proprietary (2s.)		11	6		9	9
Great Fingall (10s).		2	0		1	9
Ivanhoe (£5)	1	13	9	1	18	9
Kalgurli		10	6		12	6
Lake View & Oroya (10s.)		14	0	1	1	0
Sons of Gwalia		10	3		8	6
South Kalgurli (10s.)		6	9		5	6

GOLD, SILVER, *cont.*	Dec. 6 1918 £	s.	d.	Dec. 5 1919 £	s.	d.
OTHERS IN AUSTRALASIA:						
Blackwater, New Zealand		8	9		8	9
Consolidated G.F. of New Zealand		3	9		3	9
Mount Boppy, New South Wales		5	0		4	6
Progress, New Zealand		1	9		1	9
Talisman, New Zealand		12	0		8	9
Waihi, New Zealand	2	2	0	2	15	0
Waihi Grand Junction, New Z'lnd		15	0		13	6
AMERICA:						
Buena Tierra, Mexico	1	1	3		15	0
Camp Bird, Colorado		16	0	1	1	0
El Oro, Mexico		16	9		15	6
Esperanza, Mexico		9	0		16	6
Frontino & Bolivia, Colombia		12	6		12	6
Le Roi No. 2 (£5), British Columbia		8	9		11	3
Mexico Mines of El Oro, Mexico	6	0	0	7	10	0
Nechi (Pref. 10s.), Colombia		11	0		12	0
Oroville Dredging, Colombia	1	0	0	1	7	6
Plymouth Consolidated, California	1	3	9	1	3	9
St. John del Rey, Brazil		18	9		18	0
Santa Gertrudis, Mexico		13	3	1	13	6
Tomboy, Colorado		14	0		13	9
RUSSIA:						
Lena Goldfields	1	13	9	1	8	9
Orsk Priority		16	3		15	0
INDIA:						
Balaghat		5	6		4	0
Champion Reef (2s. 6d.)		6	0		4	0
Mysore (10s.)	2	10	0		16	3
North Anantapur		4	0		5	3
Nundydroog (10s.)	1	1	0		16	6
Ooregum (10s.)		18	0		17	6
COPPER:						
Arizona Copper (5s.), Arizona	2	5	0	2	0	0
Cape Copper (£2), Cape Province	2	17	6	2	7	6
Esperanza, Spain		8	0		5	9
Hampden Cloncurry, Queensland	1	8	0		16	6
Kyshtim, Russia	1	18	9	1	10	0
Mason & Barry, Portugal	2	12	6	2	2	6
Messina (5s.), Transvaal		5	0		5	0
Mount Elliott (£5), Queensland	3	0	0	4	5	0
Mount Lyell, Tasmania	1	6	0	1	5	6
Mount Morgan, Queensland	1	9	6	1	3	9
Mount Oxide, Queensland		6	9		9	0
Namaqua (£2), Cape Province	2	5	0	1	15	0
Rio Tinto (£5), Spain	66	0	0	45	0	0
Sissert, Russia	1	1	3	1	1	3
Spassky, Russia	2	2	6	1	10	0
Tanalyk, Russia	2	6	3	1	10	0
Tanganyika, Congo and Rhodesia	5	6	3	3	7	6
LEAD-ZINC:						
BROKEN HILL:						
Amalgamated Zinc	1	6	0	1	6	0
British Broken Hill	2	15	6	2	5	0
Broken Hill Proprietary (8s.)	3	2	0	2	12	0
Broken Hill Block 10 (£10)	1	12	0	1	6	3
Broken Hill North	3	3	6	2	15	0
Broken Hill South	13	5	0	2	7	6
Sulphide Corporation (15s.)	1	8	0	1	3	6
Zinc Corporation (10s.)	1	6	6	1	2	0
ASIA:						
Burma Corporation	4	9	6	12	12	6
Irtysh Corporation	1	18	9	1	10	0
Russian Mining	1	0	0		15	0
Russo-Asiatic	4	12	6	4	5	0
TIN:						
Aramayo Francke, Bolivia	3	1	3	4	8	9
Bisichi, Nigeria		14	0		15	6
Briseis, Tasmania		5	0		4	6
Dolcoath, Cornwall		9	0		8	0
East Pool, Cornwall	1	8	6		16	6
Ex-Lands Nigeria (2s.), Nigeria		2	9		3	3
Geevor (10s.) Cornwall	1	1	0		19	3
Gopeng, Malay	1	17	6	2	0	0
Ipoh Dredging, Malay		19	0		17	6
Kamunting, Malaya	1	12	6	2	5	0
Kinta, Malaya	2	5	0	2	10	0
Malayan Tin Dredging, Malay	2	0	0	2	2	6
Mongu (10s.), Nigeria		15	0	1	2	6
Naraguta, Nigeria		17	0		16	3
N. N. Bauchi, Nigeria (10s.)		8	6		8	0
Pahang Consolidated (5s.), Malay.		14	6		14	3
Rayfield, Nigeria		13	9		12	6
Renong Dredging, Siam	1	18	9	2	13	9
Ropp (4s.), Nigeria	1	1	3	1	6	6
Siamese Tin, Siam	3	8	9	3	2	6
South Crofty (5s.), Cornwall	1	14	6		18	6
Tehidy Minerals (15s. pd.) Cornw'l		—		1	7	6
Tekka, Malay	4	2	6	4	12	6
Tekka-Taiping, Malay	3	17	6	6	12	6
Tronoh, Malay	1	18	9	2	12	6

* Share capital expanded.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers ; also reviews of new books, and abstracts of the yearly reports of mining companies.

SULMAN ON FLOTATION.

At the November meeting of the Institution of Mining and Metallurgy, H. L. Sulman presented a paper entitled "A Contribution to the Study of Flotation." The paper occupies 100 pages of the Institution's *Bulletin*, and consists of a study, in non-mathematical language, of the forces controlling the flotation action. Herewith is given Mr. Sulman's summary. Further reference to the paper is made in the Editorial columns.

Flotation reactions result from the molecular forces acting at the surfaces of solids and liquids ; these arise from unbalanced molecular attractions in the surface-layers, which in turn are in functional relation to the balanced molecular attractions constituting cohesion for a solid or a liquid. Every solid and liquid therefore possesses excess energy at its surface, which may be exhibited in adhesion effects.

Flotation phenomena occur in accordance with the principle that where more than one equilibrium is possible, that which involves the greater diminution of the energy of the system will result.

The surface-tension of a liquid can be measured, and its changes quantified. This is not possible for solids, nor for solid/liquid systems, since the surface area of a solid cannot be altered by its unbalanced forces, as is possible for liquids. We are, however, justified in assuming surface-energy usually to be of higher order for solids than for liquids.

In a system of two immiscible liquids and two different solids, the "selective wetting" effects which occur will be in the direction of the greater reduction of interfacial energy possible for each liquid/solid couple.

Liquid/solid adhesion is reciprocal to interfacial tension ; for a liquid/solid contact, high interfacial tension implies low adhesion and flotability ; low interfacial tension means greater adhesion or wetting, and sinking.

The degree of wetting can be relatively quantified by the contact-angle made between the free surface of the liquid and that of the solid.

For pronounced flotability a contact angle approaching, and preferably exceeding, 90° is required.

For a substance in contact with a liquid to possess a contact-angle of zero value indicates that its surface energy has been reduced by wetting by the full value of that of the liquid. Flotability has been extinguished before this limit is reached ; but such degree of wetting does not imply that the interfacial tension at the contact has been reduced to zero.

For "complete wetting" interfacial tension must be *nil*, when the adhesion between solid and liquid becomes maximum. This may give rise to "sol" formation, but is coincident with the condition of "suspension" of a solid particle in the liquid when the former is sufficiently small ; it therefore coincides with complete deflocculation.

Contact-angles have a minimum and maximum value ; the angular difference between these values is the hysteresis of the contact-angle, which permits a wider range of equilibrium for a floating particle.

With crushed ore and plain water preferential wetting effects overlap, or are not usually sufficiently marked to permit of useful flotation or the separation of sulphide minerals from gangue. The addition of reagents and specific procedures are necessary to intensify such differences until they become of practical use. If water be the flotation medium, an immiscible fluid (oil) is employed to diminish to greater extent the surface energy of the sulphide, which therefore floats ; while adhesion between gangue and water (reduction of interfacial energy to a minimum) is promoted by the addition of acid or alkali to the water, so that the gangue remains submerged.

The foregoing is the statical aspect of flotation. The dynamical aspect is concerned with the molecular constitution of the interfaces, with the kinetic effects of molecular motion at the surfaces and interfaces of solids and liquids, and with those in the interior of liquids.

Solid surfaces are probably penetrable by the molecules of liquids to minute and sometimes to sensible distances ; this dynamically enhances the adhesions between them which have been considered on static grounds. Such penetration may give rise to a persistent tendency for the solid to be again wetted by the same liquid.

Solid surfaces undergo profound molecular modification by light friction ; if this take place in presence of a liquid, the molecules of the latter will be included in greater number in the modified surface than results from simple contact. These effects have important bearings on the wet-crushing of ores.

Freshly broken solid surfaces often undergo a spontaneous molecular alteration, accompanied by a diminution of surface energy ; this does not appear to be due to the adsorption of an air-film nor even to an air-borne "greasy" deposition.

Concentration of foreign molecules at the surface of a pure or homogeneous liquid (positive adsorption) reduces the surface-tension of the liquid and confers upon it the property of "frothing."

Fine mineral suspensions are adsorbed at a pure water surface, but give a film of low stability.

Many organic substances are similarly adsorbed. Those which too greatly lower the surface-tension of the water, and the strain at the solid/water interface, produce a barren "air-water" froth.

Frothing reagents useful in flotation produce a froth with water, yet leave a partial strain (mineral-adsorptive energy) at the bubble surface. The mineral adsorption now stabilizes the film, especially if the mineral be minutely oil-filmed ; still more so if flocculated. To be employed effectively the bubble-system must be disseminated throughout the mass of ore-pulp

When water-strain is completely removed from the surface of suspended particles, deflocculation results ; as by the use of acid, alkalis, silicate of soda, and certain sols with associated water agglomerates.

While a strained water-zone persists around suspended particles, these will tend to agglomerate if the particles be brought sufficiently near together to permit their strained layers to coalesce. This is aided by the brownian motion of the particles, which alone will produce slow agglomeration effects.

Flocculation is greatly increased by mechanical agitation, which naturally promotes contacts; by minutely oiling the particles, which intensifies the strain; and by contact with air (bubbles) where the surface forces, in exerting adsorption, act agglomeratively. These are factors in the "forced flocculation" necessary to produce standard mineralized froths, wherein the bubbles may be coated with a layer of scores of particles in thickness.

Generally, if a substance can be flocculated it can be floated.

Electrical phenomena are concomitants of minor order; the establishment of differing electrical potentials in frothing apparatus units has so far failed to produce any appreciable result.

Flotation therefore depends in bringing about the most advantageous selective adhesions, selective adsorptions, and selective flocculations between the complex of particles in an ore-pulp.

THE PREMIER GOLD-SILVER MINE, NORTHERN BRITISH COLUMBIA

Many rumours have been current in London during the last few months with regard to an alleged wonderful gold discovery somewhere near Klondyke. The basis for these rumours is the development of the Premier gold mine, which is situated in the Salmon River district, to the north of the Anyox mine of the Granby Consolidated, and above the head of the Portland Canal, not far from the Alaska boundary. In the map, the position of the mine is marked "Bush," which is the name of one of the pioneers. We take the following account of the mine from the *Canadian Mining Journal* for October 8. It is written by Charles Bunting, one of the earliest pioneers of the Salmon River district. For the map we are indebted to the *Mining and Scientific Press*.

The deposits were discovered and staked by William Dilworth and the Bunting brothers in June, 1910. Two claims, numbered 4 and 8, along with an adjoining group staked later by other parties, passed to the control of O. B. Bush, the Salmon-Bear River Mining Co. being organized by him during the winter of 1910—11 to operate them. The work done during the two following summers by the company consisted of short tunnels and surface cuts, and was confined to low-grade showings, the results being fairly good. A great outcrop of quartz, containing some iron pyrites, and a little native silver was "passed up" after a few shots had been put into it, and no attempt was made to trace it at the time. This outcrop has, however, since proved to be the biggest and best surface showing of a high-grade vein which has attracted so much attention. The property was then idle until the summer of 1914, when it was examined for an eastern Canadian company by W. J. Rolfe. The quartz outcrop attracted his attention and work was commenced at once. The vein was traced for fully 800 ft. down the hill in a westerly direction, the surface was stripped, and cuts put in at intervals along its whole length. The results were excellent, valuable ore being exposed in every cut, some of it running as high as $500 in gold and silver. Though securing such fine returns, for some unknown reason—possibly on account of the outbreak of the war—this company discontinued work.

The property was afterwards bonded for New York interests by H. R. Plate, and work commenced the ensuing winter. A tunnel, No. 1, was started at an elevation of 2,100 ft. on the high-grade vein, and another tunnel, No. 2, at an elevation of 1,850 ft. on the middle low-grade vein. No. 2 cut the ore-shoot diagonally for over 30 ft., the values being good. The tunnel was extended about 200 ft. beyond the ore-shoot into the country rock, and a cross-cut of 30 ft. to the left from the face was also in country rock. Work was then stopped in this tunnel. No. 1 tunnel was also driven diagonally across the ore-shoot, which left the tunnel on the right side at a point about 80 ft. from the portal. The tunnel was continued almost straight ahead—following a slip for a considerable distance—for a further 170 ft., a total of 250 ft., without picking up the ore again. A cross-cut was also driven to the right for about 12 ft., about half of it being in vein-filling, but lean. This tunnel was then abandoned. A cross-cut was then driven northerly from a gulch 200 ft. south of the tunnel. After being driven 60 ft. without getting ore, this, too, was abandoned. A cross-cut tunnel, No. 4, was now started farther down the hill, about 450 ft. below No. 2 and driven about 500 ft. before the vein was encountered. This proved to have a width of well over 100 ft., but was poorly mineralized. A drift of 40 ft. alongside a small diorite dyke was run, in which some ore was just showing when the New York syndicate threw up their bond and quit the camp, after operations extending over nearly 18 months at a cost exceeding $60,000.

In the summer of 1918, a few months after H. R Plate had left, R. K. Neill of Spokane was induced by Pat Daly—who had been foreman for both Bush and Plate and still believed it would make a mine—to look over the property. The examination and sampling proving satisfactory, Mr. Neill bonded it the following winter for $100,000, beginning work in the spring. His first work was done in No. 1 tunnel at the point where the high-grade left it to find out what happened to the ore, with the intention of following it if it continued. A few shifts sufficed to show that the vein was really paralleling the tunnel, and at no point in the whole 250 ft. of Plate's work was it more than 6 ft. away, while the face of the tunnel where work was stopped was actually in the vein. As the vein here is almost barren—assay-values $1·50—and closely resembles the wall-rock in which he had drifted for the last 160 ft., no doubt Mr. Plate failed to realize that he was in the vein. Had he, before deserting this tunnel, driven two feet to the right he would have been in $5 ore, while five feet ahead would have reached high-grade ore. This is an outstanding example of a great mine being missed by a very small margin. It is just such hazards and great rewards that gives mining the fascination no other industry possesses.

When the first work showed beyond a doubt the real direction of the ore-body, nothing more was done there. A cross-cut was started about 60 ft. farther in, and reached the ore in 6 ft. Plate's 12 ft. cross-cut was extended about 30 ft. After driving each of these cross-cuts into good ore for nearly 40 ft., without reaching the other wall, Neill decided to start a cross-cut from the face where Plate had quit, and also to drive ahead a further 600 ft. to get under the last of the series of open-cuts, which exposes the ore-shoot on the surface and shows it to have a width of from 100 to 150 ft. This cross-cut, No. 3, showed good milling-ore the first round; at 15 ft. high-grade came in and continued the full length of the cut. It was driven 82 ft. without reaching the hanging wall; a cut on the surface directly above shows fully 40 ft. of good ore yet to be cut. For some distance the full width gave values of several hundred dollars per ton in gold and silver, while the average for the entire 82 ft. is better than $55. The face of the main tunnel was swung a little to the right and driven ahead. In four feet, ore running over $125 per ton was disclosed on the right-hand side; at 10 ft. there was a full face of ore, showing considerable native and ruby silver which gave values of $153 per ton. This tunnel has since been driven about 350 ft. farther and with the exception of about 30 ft., when passing through some almost barren ground, the full width of the tunnel has been in high-grade ore, averaging several hundred dollars per ton. No. 4 cross-cut, which is in about 40 ft., cut 10 ft. of high-grade, then passed into ore of a lower grade. No. 5 cross-cut, recently started, averages $50 per ton for the six feet it is in. This tunnel is now in a distance of approximately 600 ft., giving a vertical depth of nearly 300 ft. It has still to be driven about 200 ft. to get under the great surface exposure already described. This will give an additional depth of perhaps 50 ft. only, as the hill flattens considerably above.

In the block of ground 800 ft. long and fully 100 ft. wide as proved by surface-cut and underground work and from the surface to the present level, reserves of at least 1,000,000 tons can be safely estimated with a gold and silver content of $30 per ton, making a total of $30,000,000. A thorough sampling of all the present workings and openings gives an average value of well over $30 per ton. As the ore-shoot is bigger, stronger, and far richer in the tunnel than on the surface, it is safe to assume that it will continue for at least 50 ft. below the present workings. In that event—and any engineer familiar with this ore-body would concede that much—a further $10,000,000 can be added to the above total.

MAP OF PART OF NORTHERN BRITISH COLUMBIA.
The Premier Mine is at Bush.

Work was resumed in No. 2 tunnel this summer, a cross-cut being driven to the right to cut the ore-shoot about 150 ft. east of the portal where originally cut by Mr. Plate. In about 60 ft. the ore was cut. It had here a width of 10 ft. and the average assay-value across the face was just under $20 per ton. This cross-cut was continued, and has since tapped the ore-shoot to the south, where the face is at present in good-quality ore.

During the whole summer of 1918 the mine was shut down, work being concentrated on the construction of a sleigh-road from the beach to the mine, a distance of 16 miles, and a short dock at Hyder for the purpose of shipping ore the next winter. Owing to unforeseen delays in the delivery of equipment and an exceptionally early break-up of the snow-road in the spring, only 512 tons was shipped, which gave smelter returns of $168,000.

Two stopes have been opened up, putting the mine in good shape for shipping as soon as the snow flies. Since the snow went, operations have been almost entirely confined to outside work. A portable sawmill is cutting lumber and a number of new buildings are being erected at the old camp for the accommodation of a greatly increased force of miners. The road is being widened and improved, and new barns and other buildings will be put up at the beach and the nine-mile. A new camp is being built at No. 4 tunnel.

The vein in which the ore-body occurs is a true fissure. Its strike is N. 80° E., its dip slight and southerly. The vein-filling is largely quartz-porphyry, often changed completely to quartz. The metallic minerals which can be seen are: argentite, stephanite, native and ruby silver, and iron pyrites carrying high gold values, and there is reason to believe some of the tellurides are present at times. Some fine specimens of native and brittle silver and some silver glance and ruby silver are obtained from a small persistent stringer which varies from 1 to 10 in. in width. The values of the whole ore body are fairly well divided between gold and silver, although the latter predominates.

MINERAL RESOURCES OF WEST AUSTRALIA.

The paper presented by C. M. Harris at the October meeting of the Institution of Mining and Metallurgy, entitled "Prospecting for Gold and Other Ores in West Australia," contained a comprehensive summary of the known occurrences of ores in that State. This we reproduce herewith.

The total value of the principal mineral products up to the end of 1918 was as follows:

	£
Gold	137,611,514
Coal	2,053,556
Copper	1,600,772
Tin	1,380,838
Lead	963,880
Silver	441,070

The value of molybdenite, wolfram, bismuth, alunite, graphite, mica, asbestos, scheelite, and pyritic ore totalled £27,796. Thus it will be seen that the metalliferous minerals made up by far the greater proportion, gold representing 95%, and the base metals 3% of the total output of the State. The East Coolgardie Goldfield has produced £72,500,000 of gold.

Gold.—Gold has been found under two separate conditions: (1) Native gold, throughout the goldfields; (2) Compounds with tellurium, several different species of tellurides of gold being found at Boulder, Kalgoorlie, Mulgabbie, and Ora Banda.

Of metallic minerals accompanying gold, iron pyrites is the most important; it is associated with, and also carries, gold on nearly all the fields. In the mines at Boulder pyrite is very common, either with or without the tellurides. Galena occurs in the gold reefs at Hall's Creek and all the Kimberley centres, and at Menzies, and arsenopyrite with gold at Meekatharra, Coolgardie, Southern Cross, Yuanmi, and Randalls. Zinc blende is an indication of rich ore at Coolgardie and Lawlers. Bismuth and bismutite are found in auriferous quartz at Burbanks, Dundas, Yalgoo, and Lawlers. At Burbanks, bismuth alloyed with gold to the extent of 1% has been found. Pyrrhotite occurs in quartz reefs at Southern Cross, Menzies, and Burbanks, and magnetite at Yuanmi. Chalcopyrite and copper carbonates and chalcocite are found in association with gold at Sir Samuel, Tambourah, Hall's Creek, Rothsay, and Ravensthorpe, and many other centres. Crocoite (chromate of lead) is found frequently associated with gold at Comet Vale, Ora Banda, etc. Scheelite occurs in bunches in auriferous reefs at Coolgardie and Norseman, and is usually characteristic of poor ore. Stibnite is found associated with gold at Yuanmi, Wiluna, and West Pilbara.

Quartz is the most important matrix here as elsewhere. Gold occurs in dolomite more or less ferruginous at Kalgoorlie, Kanowna, and Red Hill (Coolgardie Goldfields). Chalcedony is in many quartz veins, especially on the Ivanhoe and Boulder mines. Secondary sericite, albite, and chlorite are the characteristic minerals of most of the West Australian lode formations.

The ore deposits fall naturally into the classes: (a) primary deposits: lodes, veins, stockworks, dykes, conglomerates; (b) secondary deposits: alluvial deposits. Class (a) are of chief importance, and are found in various types of greenstones and greenstone schists, almost all of which are altered dolerites. Such conditions prevail throughout the southern and central goldfields. In the northern parts of the State, such as Kimberley, Gascoyne, and parts of the Pilbara field, the primary deposits are found in mica schists, slates, quartzites, and sandstone. The greenstones which constitute the principal auriferous belts form long but comparatively narrow belts, and extend from the south coast to the country lying between Port Sampson and Port Hedland in the north-west, about latitude 13°, and exceed 20 miles in width in places. These belts are mostly composed of altered dolerites of Archæan age, and it is almost invariably found that granites or rocks allied thereto are either immediately contiguous to the lodes or sufficiently near to have exercised some influence on the genesis of the gold and other metallic minerals.

The most important of the rock types is the quartz-dolerite on the Boulder belt, as it is in this and its alteration products that the principal gold-bearing deposits occur. The chemical alteration has converted the quartz-dolerite into an indefinite mixture of carbonate of lime, iron, and magnesia, with some residual silicates and a good deal of original and secondary quartz. The shoots of ore in these lodes are of considerable length, and maintain their value in depth, according to the dip of the quartz-dolerite, in which the Golden Horseshoe lode has been proved to a depth of 3,260 ft. Parallel to these lodes and running in a N.N.W. direction are a series of quartz-felspar porphyry dykes, and on the east and west sides of the belt are found the jasper bars, characteristic of the various auriferous areas.

To the east and north of the Boulder belt is found the calc schist in which the lodes at the Kalgoorlie end of the field occur. Here very wide lode formations are found (such as the Hannan's Reward), in which the quartz leaders run transversely, the lode being in places 100 ft. wide. The shoots of ore in the calc schist are more erratic in value than in the quartz-dolerite.

In some fields, for instance, Yilgarn, the auriferous veins are closely associated with pegmatites. The gold-bearing reefs and lodes are also common near the more or less hematite-bearing quartzites (jasper bars). The lodes may cross the bar or lie parallel to it. Pockets of gold are often found in so-called breaks in the bar at Boogardie, while at Sandstone enrichments in the lodes in proximity to jasper bars are very noticeable. In Westonia the pegmatite dykes are a source of great annoyance, constantly crossing the lode, but generally speaking where these dykes are absent there is little or no gold, so that they are not altogether unwelcome.

In addition to the veins and lode formations, gold is also found as a secondary constituent in the conglomerate, which is of sedimentary origin and is made up of rounded and sub-angular fragments of the underlying strata at the base of the Nullagine series and has been mined in two localities, Nullagine and Just-in-time. The natural difficulties, hardness and size of the boulders, tropical climate, together with the irregularity in the grade of the conglomerate, have hitherto made the working unprofitable. At a later date, when the Pilbara, Gascoyne, and Ashburton goldfields come into their own and are able to attract a settled population, it is quite possible that this and many other low-grade deposits will be worked to profit.

At Mt. Singleton another conglomerate is found, which, like the Nullagine, contains the gold scattered in irregular quantities through the conglomerate, and extends for miles. The deposit in this case is only slightly inclined and was prospected by means of a shaft sunk on the lode from the summit of a hill with a little driving, but the results were not encouraging. However, the owners are now cross-cutting from the side of the hill through the sandstones and grits which are found on either side of the conglomerate. They have found gold in several soft seams which apparently have been impregnated with gold from the same source as the conglomerate. Although at the present time no profitable ore has been found in this deposit, the results of the prospecting work on this conglomerate will be watched with considerable interest.

At Kanowna, chloritic, talcose, and serpentine schists are crossed by dykes of acid rocks (that is granitic). The schists are highly auriferous in places, and at times the quartz veins in granitic rocks contain gold. The alluvial leads have been extensively worked, the most prominent being the North Lead. This lead lies in an old watercourse carved out of older rocks, and has been proved to be not merely a simple isolated run of auriferous gravel, but part of a series of old stream deposits. The deposit consists of surface loam, underlain by a gravelly ironstone, often partly cemented by kaolin and oxide of iron into solid rock. Beneath this lies a bed or beds of practically pure kaolin (locally called "pug "), and a varying thickness of a pebbly quartz wash. This wash is occasionally cemented by a secondary silica into a hard compact quartzite. Most of the gold has been won from the quartz wash, although the overlying kaolin and ironstone gravel have also yielded fair quantities of gold.

The Adeline Lead, Kalgoorlie, apparently started from the surface of an ironstone hill, where it only contained traces of gold, and gradually inclined downward until, at a depth of 40 ft., it crossed a tributary having its source on the Golden Eagle lode, when the wash immediately became much richer in gold. The highest grade wash consisted of ironstone pebbles on the south bank, that is whence the tributaries came.

Copper. Although copper is found throughout the State in various forms and quantities, from quartz lodes containing gold and traces of copper, to bonanzas of copper glance, there are only four fields which are worked for this metal now.

The Phillips River district consists of a series of metamorphic-sedimentary rocks associated with a complex series of crystalline rocks, which range from granite to serpentine, with their cleaved and schistose varieties. The lodes are of two types, the first basic cupriferous dykes, and the second silicious or ferruginous veins, containing gold and copper, which are worked for their gold contents as well.

At Whim Creek (West Pilbara), which is the largest and richest copper body yet discovered in West Australia in the oxidized zone, the country rock is a weathered talcose schist, associated with beds of sedimentary origin. The deposit is a flat-lying lode, conforming to the bedding of the enclosing schist country, which has a general strike of north-west and south-east. Hitherto, only the irregular patches of high-grade ore have been mined, but it is proposed to install the Peachy leaching process, by which 2% to 4% ore will be treated in large tonnages.

The ore at Anaconda in the Mt. Morgans district is in a basic rock, with quartz, jasper, and ironstone veins, which show little or no copper at the surface. At a shallow depth there have been zones of enrichment where the chalcopyrite has been converted into carbonates, and at greater depths into chalcocite ; these bonanzas were picked out and smelted, but the chalcopyrite at a greater depth is now being mined for its sulphur content, with copper as a by-product.

At Ilgarere, 200 miles north of Meekatharra, the most recently discovered deposit, the lodes consist of a series of narrow lenses in slate carrying high-grade carbonate and silicate of copper with a little copper glance.

Tin.—There are only two districts in West Australia in which tin is being mined, at Greenbushes and Pilbara. Several smaller finds have been made, but owing to their inaccessibility very little prospecting work has been done on them. The alluvial deposits are by far the most prevalent, and at Greenbushes they are derived from tin-bearing granite. The highest grade wash is found in the decomposed granite bottom in the old gullies, running transversely across the tin-bearing rock, which is a pegmatite. Cassiterite as a detrital deposit is found adjacent to these dykes, and at other times in gullies crossing the pegmatites at Moolyella.

Lead.—The lead mines on the Northampton field occur in garnetiferous granite. Parallel to the lodes and extending in places for miles in length are a series of basic dykes. Sometimes the lodes are found on the contact of the dyke and the granite. In several of the lodes at Northampton, copper ore was found at the surface, then copper and lead, and at depth lead only. In the Narra Tarra mine at Protheroe, at the 300 ft. level, rich lead ore extends right up to a fault plane, and on its south side is chalcopyrite, containing little or no lead. At Geraldine the lodes contain very pure galena, which in the Surprise mine assays 50% lead over a width of 10 ft., with only ½ oz. of silver to the ton. The characteristic of this field is that the lodes, like the basic dykes, extend for considerable length, shoots of 500 ft. to 1,000 ft. being common.

Other Ores.—Scheelite is associated with gold in quartz lodes in greenstone country at Norseman, in greenstone lode formations at Comet Vale, in pegmatites and in biotite schist at Melville (Yalgoo). It is being mined at the latter centres for scheelite and bismuth. In order to encourage the production of scheelite, the Government has erected a dressing plant at Coolgardie, so that a concentrate can be produced, thus improving on the former primitive method of hand-picking, which precluded the mining of all but the highest grade of ore.

Wolfram is usually found in quartz veins and pegmatites as at Federal Downs (West Kimberley) and Mt. Singleton (Yalgoo), and in the auriferous reef in the Edna May Deep Levels, but so far the percentage of wolfram in the ore is too small and the distance from the ports too great to make it profitable to work.

Tantalite is frequently associated with tin in pegmatites at Greenbushes and Wodgina, but there is difficulty in finding a market for this ore, and it is not mined by itself.

Bismuth occurs with scheelite at Melville as a carbonate and is very pure, but the present demand is too small to warrant extensive working, and only the richest pipes are mined.

Molybdenite is found in quartz and in pegmatite dykes, while the best deposit is found in shear zones and as impregnations in granite intrusions into greenstone, at Warriedar (Yalgoo). Here it is associated with scheelite, wolfram, fluorite, and pyrites, and the latter contains traces of bismuth. This deposit can be traced on Mulgine Hill for a mile in length and over a considerable width in patches. The main ore channel is 200 ft. wide, and so far as it is opened up is estimated to carry 3% to 4% of molybdenite in shoots averaging 5 ft. to 6 ft. in width. The ore could be mined and concentrated cheaply, but here again the world's supply is at present much greater than the demand, and the active development of this rich and large ore channel has been postponed.

In the Weld Range at the head of the Roderick River is the Wilgi-Mia hematite deposit, said to be one of the richest iron lodes in the world. The softer bands in it have been worked for war paint by aboriginals to a depth of 100 ft. The ore-body is 3 miles long and 150 ft. to 200 ft. wide, and is probably a replacement lode in the greenstones which constitute the main axis of the Weld Range of which it forms a part.

There is also an iron deposit on Yampi Island. This island is situated on the north-west coast and is about ¾ mile from the mainland, with precipitous cliffs of quartzite, which rise to heights of 300 ft. to 600 ft. above sea-level. Parallel to the major axis of the quartzite there are two lodes of almost pure hematite up to 30 ft. wide. At one point the hanging wall of quartzite has slipped off into the sea. This has left a face of hematite 300 ft. high, ready to be stoped off and conveyed by gravitation direct to a steamship at a very small cost. It is estimated that there are at least half a million tons of this ore exposed, without any overburden at all. The harbour is now being buoyed and a company proposes to commence active operations to work this deposit.

Mr. Harris's paper contained also some notes on the West Australian resources of non-metallic minerals. This section was not printed in the paper as it appeared in the Institution's *Bulletin*; we reproduce it herewith in order to make Mr. Harris's treatment of the subject complete.

Graphite.—Flake graphite occurs in bands of schistose rocks distributed throughout the State. Its graphitic content varies up to 50%, and a very high class of ore is found at Kendinup in greenstone schists near the granite contact. Several lots of hand-picked ore have been sent to London for the purpose of testing the quality, and is given as being worth £20 per ton at Fremantle. The opening up of the deposits must depend upon the erection of a dressing-plant to produce a concentrate of sufficient grade to pay to ship.

Asbestos.—The hornblende variety found in amphibolites is of fairly frequent occurrence, but it is too hard to be of any commercial value. There are, however, several areas in which the chrysotile variety occurs. At Soanesville (Pilbara), it is found as stockworks in narrow bands of serpentine, adjacent to greenstone dykes. The veins are from ⅛ in. to 4 in. in width, and of the highest tensile strength. At Nullagine it occurs in serpentine carrying interlacing veins of asbestos, in circular zones round a core of another rock. The veins are found up to 8 in. in width, and like the asbestos at Soanesville it is of the highest quality and is a true chrysotile. Smaller occurrences are met with near Ravensthorpe.

Mica.—Lepidolite (lithia mica) occurs in granite country forming one of the constituents of pegmatite at Londonderry (Coolgardie). Experiments are being made to see whether it can be utilized for electrical work. Muscovite is being worked at the Lockyer Range on the upper Gascoyne River and occurs in pegmatite. Some of this is as clear as glass, but other portions are darkened by included films of magnetite. Sheets up to 8 in. square are found, but the average is smaller. Other deposits are found at Mullalyup (S.W.) and at Northampton, but are not being worked.

Salt.—This is harvested from depressions in the calcareous sandstones on the coast at Rottnest, Esperance, and Hutt's Lagoon. The salt is derived from the sea spray, which blows in during the winter, and the water being evaporated during the hot dry summer the salt is left behind. It is also found in the arid portions of the State, as at Lake Raeside and Cow Cowing, and may represent the residue of an ocean of a recently past geological age. The salt, as it is taken off, is renewed by capillary action from the huge subterranean supplies of saturated brine in the muddy beds of lakes. There are not any solid salt-beds underground, as there are in England.

Gypsum.—The deposits of this mineral are generally associated with salt, as if in the evaporation of the water in the beds the gypsum crystallizes out. The general form is in the dunes of loose floury gypsum, called "kopi," which is blown up from the dry lake beds, and deposited on the first obstruction, such as shrub. It is frequently too discoloured with red clay to make good plaster, but is used as a fertilizer. In several large salt lakes near Dongara, there occur deposits of crystallized gypsum several feet in depth, which gives a white plaster, and is being mined for such.

Phosphates.—Guano is found from 4 to 27 in. thick on the islands near to the coast about Geraldton. On the Midland Line there are deposits of coprolite, carrying as high as 39% phosphoric acid. They occur as nodules in deposits which are found extending from Gingin to Dandaragan, over 100 miles in length, in Cretaceous rocks, the matrix being either chalk or glauconite.

Potash.—Alunite, which is a hydrous sulphate of aluminium and potassium, occurs as veins up to 24 in. wide, and as scattered nodules of various sizes, embedded in the kaolinized slate so prevalent at Kanowna. The result of the examination of this recently discovered mineral of West Australia, shows that further exploration is warranted to see whether it can be converted into a fertilizer, at a price to compete with the imported potash salts. The Government has secured a plant to treat the alunite, and proposes to work one of the mines at Kanowna. A list of prices has been issued that will be paid for this mineral, according to the percentage of potash in it. The recognition of both alunite and jarosite is to be credited to the Government Mineralogical Staff. The Government is considering the enlargement of this branch of the Geological Survey, to carry out more extensive research work into the utilization of the mineral resources of the State.

Lead in South Africa.—As mentioned last month, the Department of Mines of the Union of South Africa has published a pamphlet, written by Dr. Wm. Versfeld, describing the base-metal resources of South Africa, particularly those of the Union. Readers of the Magazine are fairly well acquainted with the copper, tin, manganese, nickel, antimony, and chromite deposits. On the other hand, the lead occurrences are not so generally known. This, together with the fact that the Albu group are intending to reopen lead workings in the Pretoria district, makes the reproduction of Dr. Versfeld's description a matter of current interest.

Lead ores occur in South Africa, as in many other parts of the world, in the limestones and dolomites of the older geological formations. Small pockets of galena, in some cases argentiferous, are frequently found in the dolomite series of the Transvaal. In the Pretoria series true veins are found carrying galena either alone, or associated with gold, silver, copper, and cobalt. In the Pretoria, Rustenburg, and Marico Districts there are many vein deposits of lead ores associated with copper, the best known being the Transvaal silver mine in the Pretoria District, where argentiferous galena is associated with iron pyrites, copper pyrites, copper carbonates, and tetrahedrite, in a gangue of siderite. This vein is associated with a diabase dyke. At Edendale, four miles north of Hatherley, also in the Pretoria series, a vein has been worked in which galena occurs in conjunction with zinc blende and the usual oxidized ores of lead and zinc. The gangue material is mainly quartz and calcite. At Leeuwkloof (Pretoria District) and Rhenosterhoek (Marico District), lead ore has also been worked. At Leeuwkloof the galena occurs in the form of a large shoot in the dolomite underlying the shales of the Pretoria series, and at the contact with the shales. The shoot runs north-west and south-east, and dips to the south-west. The galena is of good quality, the 700 tons so far extracted averaging 73 to 75% of lead. The silver value is fairly constant, always being between 2 and 4 oz. per ton. Associated with this lode is a large body of iron pyrites about 100 ft. thick.

At Rhenosterhoek the deposit is also in dolomite almost at its junction with the Pretoria series. The occurrence is similar in character to all the other small galena deposits in this district, the ore usually being brought under notice through small outcrops of galena showing on the surface, and in almost all cases decreasing in value with depth, usually giving out at a depth of about 50 ft. or less. The deposits were discovered in this manner some thirty-five years ago, and a small amount of galena was at that time taken out by means of open-cut workings. The mine is now being worked through an adit driven into the base of the hill on which the deposit occurs, at a level of 75 ft. below the original outcrop, at which depth solid dolomite is met with, and the vertical extension of the galena deposit, in its original form, appears to be reached. The ore is extracted principally by overhand stoping, and the deposit increases in value as the work approaches the surface. The galena occurs in irregular masses and in characteristically shaped lumps (the latter weighing from a few ounces to several tons each), and is found embedded in a soft brown earth or wad, which carries about 10% of manganese dioxide. This earth is the result of an alteration or replacement of the dolomite, and occurs in large masses or pockets bounded on all sides by solid dolomite, and also having embedded blocks of slightly altered dolomite, varying from small boulders to blocks of huge size, together with layers of shale and small stringers of quartz. The galena is pure in quality, the average assay-value of consignments in bulk being 83% lead. It carries silver to the extent of from 9 to 15 oz. to the short ton. A small amount of cerussite, finely crystallized, occurs in cavities and in small clusters, and some minium is also found, usually in the form of a thin coating on the galena. The mine is not being worked to its full capacity, owing to the impossibility of shipping the ore during the continuance of the war and to the very limited local market. The ore now being taken out is smelted in Johannesburg, and is used principally in the manufacture of nitrate of lead.

At a number of other localities in the Transvaal, lead has been mined in the past, but the mines are at present shut down, some only on account of the war. The chief localities are Witkop, Bokkraal, Buffelshoek, Rietspruit, and Doornhoek (all in the Marico District), Broederstroom, Edendale, Dwarsfontein, and Roodekrans (all in Pretoria District), and Windhuk, in Pietersburg District. Throughout the whole of the dolomite area of the Transvaal irregular deposits of galena are found and occasionally worked, the ore being sold to ore-reduction companies on the Rand. A fissure vein was formerly worked near the Railway Station of Argent, 50 miles east of Johannesburg, and several other such occurrences are known in Northern Transvaal, Waterval Onder, Natal, and Gordonia. Near Potgietersrust (Transvaal) is a lead deposit situated on a ridge which forms the boundary between Uitloop and Rietfontein. The main occurrence is in a narrow but sharply defined zone of altered granite, which strikes approximately north and south, and dips at a big angle to the west and is traceable for some distance. A similar occurrence has been noted a short distance to the west. The lodes are characterized by bluish chert-like rock in the altered granite, associated with fluorite and galena. The country rock is the older, or Archæan, granite.

In the Cape Province lead ores occur at the Maitland mine, near Port Elizabeth, associated with copper, silver, and antimony, at Banghoek, 40 miles west of Hopetown, in quartz veins at Knysna, at Richmond, and in the Beaufort West and Victoria West Districts. In the Bokkeveld series of the Caledon and Swellendam Districts of the Cape Province a number of white quartz veins are noticed, some containing small quantities of galena, with copper and iron pyrites. These do not appear to be of commercial importance. A little galena has also been obtained from a vein in a Karroo dolerite near Sutherland. The writer has also examined specimens of lead ore in reef quartz from Kakamas, Griquatown, and Montagu, in dolomite from Bechuanaland, in the form of cerussite (with malachite) from Damaraland, and other ores from Burghersdorp and Van Rhynsdorp. In the last-named district a large vertical reef has been discovered, consisting at the surface of pyromorphite (lead phosphate) associated with copper and antimony.

In Natal no extensive deposits of lead ores are known, but some prospecting work has been done on a quartz vein in the bedding planes of a schist in the Mfongosi and Ngobevu Valleys, near the Tugela River in Zululand. The vein varies in width from 3½ to 14 ft., and contains, where opened, only small and isolated nests of galena, so the prospects are not very promising. Galena has also been found at Umsingi and in Umvoti County.

In "German" East Africa lead ore occurs in auriferous quartz veins and in pegmatites. In South-West Africa it is one of the chief constituents of the copper-lead deposits of Otavi; argentiferous galena is found at Pomona and at Aiais, on the Fish River, and in other localities; copper-lead ore is found in quartz reefs in granite, south-east of the Little Karas Mountains. In Northern Rhodesia lead occurs with zinc at Broken Hill.

As lead ores have been proved to occur at numerous localities where dolomite is found, and as they seldom form easily recognizable oxidation products at the surface, it seems extremely likely that there must be numerous occurrences still undiscovered. The limestones and dolomites of the Otavi series in South-West Africa, the Malmesbury, Congo, and Ibiquas series of the Cape Province, and the dolomite series of the Transvaal, are very largely covered with soil owing to the ease with which they weather. They have, in consequence, been little prospected, and, though prospecting will not be easy, there seems little doubt that many discoveries will in time be made. The deposits so far known are of such a nature that under existing conditions only small profits, if any, can be made. There appears to be no reason, however, why lead mining in South Africa should not be made very profitable with proper organization and co-operation, seeing that a considerable local demand will always exist.

Potash Salts in South Africa.—In the May issue, a brief note was made of deposits of nitrate of potash found in the districts of Prieska and Hay, Cape Province. These deposits have been known for many years, and at one time the Consolidated Gold Fields of South Africa was interested in them. Just recently W. E. Bleloch has been endeavouring to develop them through the South African Nitrate & Potash Corporation. Considerable light is thrown on these deposits by Memoir No. 14 of the Departments of Mines of the Union of South Africa, written by G. E. B. Frood and

A. L. Hall. The following is a summary of their conclusions:

In the districts of Prieska and Hay, nitrates, essentially potassium nitrates, occur at a large number of localities within the limits of one formation, the ferruginous shales of the Lower Griqua Town Series, usually inclined at low angles. They lie especially along the basal portion of thicker krantzes, often associated with caves, recesses, and other places protected from rain. Saltpetre is found in the visible form as incrustations and irregular pockets or short veins on joint faces, bedding planes, etc., but also exists in yellow layers, usually where the strata are more thinly bedded. In the latter case, its existence is not directly apparent, but can be proved chemically or by natural efflorescence. No satisfactory figures can be given as to the average nitrate content, since this varies from point to point, but both on the organic and the atmospheric theory, the richest portion of nitrate-bearing shales are likely to be those nearer the present surface. The distance to which nitrates may be expected to persist on the dip is uncertain, as enough systematic exploratory work, such as shaft-sinking, is not yet available; under favourable conditions, one would expect it to be expressed in tens of feet. The source of the potash is primary, and lies in the shales; that of nitrogen is nitrogenous material supplied by animal and probably also vegetable life, but atmospheric nitrogen may have played a subsidiary part. The formation of nitrate of potash is bacterial, and since this must occur under conditions of free aeration, this nitrification is characteristic of the belt of weathering, and would gradually diminish in proportion as the shales become more compact in depth. It does not necessarily follow that because the source of nitrogen is held to be chiefly that of nitrogenous material, large quantities could not be found, given long periods of geological time.

Goodchild on Ore Deposits.—The November *Bulletin* of the Institution of Mining and Metallurgy contains a written contribution by F. P. Mennell to the discussion on W. H. Goodchild's paper on the "Evolution of Ore Deposits from Igneous Magmas."

Mr. Mennell says that though he has doubts concerning the applicability of the principles cited by Mr. Goodchild to the great majority of ore deposits it is not from want of sympathy with the employment of scientific methods in attacking the problems they present. He is inclined to think that a wider range of observation would have convinced Mr. Goodchild that the direct application of his ideas is involved in much greater obscurity than he is now prepared to admit, but at the same time Mr. Mennell trusts that adverse criticism will not deter Mr. Goodchild from fresh efforts in this interesting field. Mr. Mennell's own experience of ores which are generally assumed to be genetically connected with igneous rocks is considerable, and he confesses that he finds the evidence from which their supposed direct magmatic concentration is inferred of a very unsatisfactory character. His own belief is that even where primary magmatic concentration is admissible, at any rate as a working hypothesis, the really valuable ores have in every case been concentrated by subsequent enrichment processes, which are thus of far greater practical importance than any speculations regarding the original source of their metallic contents. It may readily be admitted that igneous rocks have had much to do with the formation of many ore-bodies, but the nature of their influence is still under discussion.

Mr. Mennell goes further and argues that it is clear that many of the most important metals have no special association with any particular igneous rock, if indeed they are associated with igneous rocks at all. The very varied conditions under which some of the most important metals occur seem far from pointing to the origin of the deposits from any one process or source. The largest and richest copper lodes in the world, those of Katanga, and the highest grade lead and zinc deposits known, those of Northern Rhodesia, are situated among sedimentary rocks and appear to have no connection of any kind with igneous masses. The data in regard to such problems as Mr. Goodchild has tackled are admittedly scanty, but there are some which he appears to have overlooked. One would expect that as a metallurgist he would have been able to reinforce some of his arguments by observations on mattes and slags. What is known of mattes does not seem to support the suggestion of expansion in cooling, and although this admittedly rests on the assumed presence of excess sulphur, it is necessary to consider the volume relations of that element before it entered into the matte There are also facts connected with igneous rocks which do not seem to square with the suggestion that lime exists in what Mr. Goodchild terms allotropic forms. Mr. Goodchild regards felspar-lime as a low-temperature form and pyroxene-lime as a high-temperature form. Yet it is known from observation that pyroxene exists in rocks which were certainly not formed at high temperatures. It even occurs in contact-altered limestones in the vicinity of small dolerite dykes intruded close to the surface, to say nothing of rocks round granite masses, such as that of Dartmoor, where the limestones are recrystallized, largely into pyroxene, on the outer edge of the contact zone, where even the adjacent shales have remained unaffected. But there is much more to be urged against it than this, namely, that pyroxenes and lime felspars coexist in almost every occurrence of basic igneous rock, and with variable orders of crystallization. In fact, the production of pyroxene or felspar does not depend on temperature at all, but is simply regulated, as can be done experimentally, by adjustments of the chemical composition. His slaking hypothesis is also rendered unnecessary by the ready way in which these minerals can be produced from anhydrous melts of suitable composition either alone or in company, and either of them can be caused to crystallize out first, as Fouqué and Lévy showed many years ago, by merely modifying the rate of cooling.

Pitchblende in Ontario.—In the *Canadian Mining Journal* for October 14, Cyril W. Knight, of the Ontario Bureau of Mines, describes the occurrence of pitchblende exceptionally rich in radium in Butt township to the east of Georgian Bay. The township is east of Scotia Junction on the Grand Trunk Railway, and about 170 miles north-by-east of Toronto. The country is for the most part rugged. The hills rise two or three hundred feet or more above the valleys, which are filled with sand and gravel. The rocks are largely covered with drift, making prospecting difficult. Mica has been mined in a small way in this part of the country, on and off, for years. The pitchblende occurs sparingly in a coarse granite pegmatite dyke, striking north 25° E., and dipping at about 60° to the north-west. The dyke has been worked by an open-cut about 40 ft. long and 7 or 8 ft. deep. It occurs at the edge of a small lake, locally known as Mica lake, which has been partly drained in order to prevent the pit being flooded during mining operations. The width of dyke is not known, as only the foot-wall has been exposed by the pit, but it appears to be at least 3 or 4 ft. wide. The length of the dyke is also not known, the surface being covered with drift; the open-cut shows it to have a length of at least 40 ft. The dyke consists of white felspar, red felspar, white quartz, smoky quartz, white mica, black mica, a little tourmaline, pitchblende, and other minerals in small quantity, which have not as yet been identified. The pitchblende appears to be associated with the red felspar, in which respect it resembles the occurrence of euxenite, a radium bearing mineral, in Lanark county, Ontario, described in the 26th Annual Report of the Bureau of Mines, 1917. The euxenite of Lanark county also occurs in a coarse granite pegmatite dyke. As regards the general geology of this part of the Province of Ontario, the country rock is pre-Cambrian in age, and consists of banded gneisses, such as granite gneiss, mica gneiss, quartzite gneiss. These banded gneisses cover a great area, extending from Georgian Bay eastward to the Province of Quebec, and from about Lake Timagami southward almost to Lake Simcoe, a distance of some 150 miles. The gneisses are everywhere cut by numberless dykes of granite pegmatite. It is in one of these dykes that the pitchblende in Butt township and the euxenite in Lanark county occur. The number of coarse granite pegmatites is so great in Ontario as to encourage the hope that pitchblende or some other radium bearing mineral may be found in large quantities. The pitchblende in Butt township was discovered by Wm. Elliott, who has worked the deposit for mica from time to time during the past three years. About a ton of mica has been mined and shipped. Mr. Elliott noted the presence of a black, heavy mineral which he eventually forwarded to Ledoux & Co., New York, who gave him the following report, sample No. 1 being the mineral itself, and sample No 2 the felspar in which it occurs: "No. 1, uranium oxide (U_3O_8) 74·98%; No. 2, uranium oxide, 0·42% Sample No. 1 appears to be pitchblende; it contains approximately 10% of lead. The radio-activity as determined by the electroscope is very high. Calculated at the usual uranium ratio, the sample contains radium in the proportion of about 190 milligrams per ton. It is impossible to even approximate the value of such extraordinarily rich ore, as there are no established quotations. We think you would be safe in taking $3·00 per pound for the uranium oxide contained as a minimum, which would give a value of about $4,500 per short ton. Sample No. 2 is too low grade to be of any commercial value." The pitchblende occurs in grains about the size of peas or larger. Mr. Elliott reports that he has found the mineral occurring in masses as large as an egg.

This is the second occurrence of radium bearing material in Ontario reported since the Legislature offered a reward of $25,000 to the first discoverer.

Aluminium from Labradorite.—In *Nature* for October 23, L. Hawkes described the Goldschmidt process for producing aluminium from labradorite, one of the felspar group between albite and anorthite and containing on an average 30% Al_2O_3. The process was invented by Professor Goldschmidt, of the Mineralogical Institute, Christiania. The mineral is treated with dilute nitric acid, which dissolves the aluminium, calcium, and sodium constituents, together with a little iron, the silica and most of the iron being unattacked. After the removal of the dissolved iron, the solution is evaporated and the solid residue heated to the point where aluminium nitrate is decomposed but not the calcium and sodium nitrates. The aluminium is obtained as pure oxide suitable for the electric furnace, while the expelled nitric acid is recovered. The process is believed to be suitable for use in Norway, where labradorite is fairly plentiful and electric current can be applied in the reduction of alumina and the production of nitric acid.

SHORT NOTICES

Coal in the Midlands.—The *Colliery Guardian* for November 21 reprints papers read by G. A. Longden and J. Ford before the Midland Counties Institution of Engineers describing recent borings in the Nottingham coalfield. These papers throw light on the possibilities of extension of the Midland coalfields.

Edna May.—The *Proceedings* of the Australasian Institute of Mining and Metallurgy, No. 34, contains a paper by M. T. Williams on the ore treatment at the Edna May gold mine, Westonia

White Pigments.—The *Journal* of the Franklin Institute for November contains a paper by A. H Pfund describing an instrument for measuring the covering power of various white pigments

Determination of Potash.—The *Journal of Industrial and Engineering Chemistry* contains a paper by T. E. Keitt and H. E. Shiver on the De Roode method of determining potash.

Estimation of Arsenic.—The *Journal of Industrial and Engineering Chemistry* for October contains an article by John Waddell describing modifications in Pearce's method of estimating arsenic in ores.

Cyanide Manufacture.—The *Journal of Industrial and Engineering Chemistry* for October contains a paper by J B. Ferguson and P. D. V. Manning describing studies of the Bucher process for making cyanide of sodium by heating carbonate of soda, carbon, and iron in an atmosphere of nitrogen.

Cyanide Manufacture.—The *Journal of Industrial and Engineering Chemistry* for November contains a paper by C. O. Brown, describing the plant operated by the United States Government for the manufacture of sodium cyanide, at Saltville, Virginia. The process is that known as Buchner's and involved the treatment of soda-iron-coke briquettes with nitrogen at a temperature of 1,000°C.

Silicate of Soda.—The *Journal of Industrial and Engineering Chemistry* for November contains a paper by J. G. Vail on properties of commercial silicate of soda.

Palladium in Alaska.—In the *Mining and Scientific Press* for October 11, D. G. Campbell describes the occurrence of palladium with platinum at the Goodro copper mine on Prince of Wales Island, Alaska.

Korean Mining.—In the *Mining and Scientific Press* for October 11, A. R. Weigall and J. F. Mitchell Roberts commence an article on the technical operations on the Suan Concession owned by the Seoul Mining Company.

Harricana River, Quebec.—In the *Canadian Mining Journal* for October 14, A. Mailhiot gives an account of the Upper Harricana River gold district, Quebec, which is situated on Martigny lake, 430 miles west of Quebec City and 140 east of Cochrane, Ontario. The Harricana River flows into Hudson Bay.

Utah Copper.—In the *Mining and Scientific Press* for October 4, Frank G. Janney writes on the power-plant, machine shop, and foundry of the Utah Copper Company.

Petroleum Supplies.—At the meeting of the Institution of Petroleum Technologists held on November 18, Rear-Admiral Philip Dumas read a paper on the conservation of oil

Utilizing Slate Refuse.—The *Chemical Trade Journal* for November 8 gives some particulars of the industry started by the North Wales Development Company in connection with the utilization of slate refuse The material is ground fine and marketed under the name of "myrtox." This is said to be of use as a filler in a great variety of manufactures from rubber and linoleum to paints and pottery.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W C.2. with a note of the number and year of the patent.*

14,950 of 1917 (133,336). H. WRIGLEY, H. SPENCE, and PETER SPENCE & SONS, Manchester. Improved methods of obtaining titanium compounds from ilmenite.

6,185 of 1918 (134,240). F. RIES, New York. Improved machine for cutting and polishing gems.

10,978 of 1918 (133,367). S. B. WILSON and PUREX LTD., London. Improved method of making basic lead sulphate pigment from galena.

12,363 of 1918 (133,981). H. A. BLACKWELL, Liverpool. Improvements in the method of producing ferro-tungsten and other tungsten alloys by the alumino-thermic method of reduction.

16,175 of 1918 (123,715). STURTEVANT MILL Co., Boston, Mass. Improvements in pulverizing mills.

16,325 of 1918 (120,044). O. REECE, Sydney. Method of briquetting fine concentrate, flue dust, etc., for treatment in the blast-furnace.

16,528 of 1918 (133,448). W. MAUSS, Johannesburg. Centrifugal separator for separating solids from liquids.

16,742 of 1918 (133,753). R. D. PIKE, San Francisco. Method of manufacturing magnesite refractories.

17,081 of 1918 (133,474). E. E. and P. C. DUTT, Jubbulpore, India. Method of producing potassium fluoride from felspar by reaction with silicon tetra-fluoride and water vapour.

17,702 of 1918 (134,311). G. J. SHORT, Plymouth, and J. H. WILLIAMS, Truro. Surrounding the steel of a rock-drill with a water chamber from which issue water jets.

18,028 of 1918 (133,498). LUCKENBACH PROCESS CO., San Francisco. The use as a frothing agent in flotation of a solution produced by boiling greasewood shrub in water containing soda.

18,335 of 1918 (134, 626). J. C. DELAGE, Bordeaux. Manufacturing magnesia from dolomite

18,495 of 1918 (121,591). G. HAGLUND, Christiania. Electrolytic method of separating copper and nickel or other metals.

19,606 of 1918 (134,387). A. RAMEN, Helsingborg, Sweden. Method of briquetting burnt ore.

20,009 of 1918 (134,665). E. BURY, O. OLLANDER, T. SMITH, and F. BAINBRIDGE, Saltburn by Sea. Improvements in the method of recovering potash salts from blast-furnace slag.

6,251 of 1919 (134,155). W. J. and W. R. BATES, Stafford. Method of treating spathic iron ore for use in the manufacture of hydrogen.

7,467 of 1919 (125,064). F. L. SMIDTH & CO., Copenhagen. In tube-mills and ball-mills, an improved method of arranging screens at the discharge end, the duty of which is to return large particles to the mill.

14,244 of 1919 (133,642). G. RAYNER, Sheffield. Improvements in the valves of rock-drills.

18,258 of 1919 (131,281). RAYMOND BROTHERS IMPACT PULVERIZING CO., Chicago. Improvements in pulverizers in which the centrifugal force of rollers against a ring is utilized.

14,332 of 1919 (133,277). LUCKENBACK PROCESSES, INCD, San Francisco. Use of rubber solution as a selective agent in concentration by flotation.

12,504 of 1919 (133,001). J. A. YULE, Glasgow. Method of making drill steels.

NEW BOOKS

☞ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

The Mineral Industry, 1918, Vol. 27. Edited by G. A. Roush and Allison Butts. Cloth, octavo, 955 pages. Price 50s. net. New York: McGraw-Hill Book Co.; London: Hill Publishing Co., Ltd.

This famous year-book requires no special notice; suffice it to say that the old contributors are still in evidence: J. W. Richards, R. H. Richards, W. R. Ingalls, L. S. Austin, G. F. Kunz, David T. Day, H. O. Hofman, Walter Harvey Weed. Fortunate is the editor who can induce eminent men to write yearly reviews of progress.

Analysis of Minerals and Ores of the Rarer Elements. By W. R. Schoeller, Ph.D., and A. R. Powell. Cloth, octavo, 240 pages. Price 16s. London: Charles Griffin & Co., Ltd.

This adds another useful treatise to the already long list of books in Griffin's series. As its title implies, it fills a want to those engaged in testing minerals for commercial value by supplying in a concise form particulars of those elements which up to a few years ago were only of scientific interest. Recent strides in metallurgy, however, have made it incumbent upon all who examine minerals for commercial purposes to investigate those which used to be described as rare metals, many of these metals now being employed in the manufacture of commercial alloys.

The method of the present volume is to give the mineralogy of the metal, followed by its properties and compounds, and then its quantitative separation, and a scheme for the complete analysis of the mineral. This latter section is a feature of the work and should be useful. The order of arrangement of the elements follows that of the Periodic Law and comprises the following elements: Lithium, rubidium, and cæsium; beryllium and radium; scandium, gallium, indium, and thallium; cerium and other rare earths; titanium, zirconium, thorium, and germanium; vanadium, columbium, and tantalum; selenium, tellurium, molybdenum, tungsten, and uranium; ruthenium, rhodium, palladium, osmium, iridium, and platinum.

There is no complete index to the book, but the authors have replaced this by two smaller indexes, one giving the minerals and the other the separations of the elements. Whether this plan will be as useful as a complete index, which is generally one of the most helpful features in a work such as this, remains to be proved.

The authors lay great stress upon the method of preparation of the sample for analysis; certainly this is a fact that is often lost sight of, however carefully the chemist may work on the prepared sample. If that sample does not truly represent the average of the mineral to be assayed, or is not ground to the required fineness, his work becomes valueless, or, to say the least, greatly depreciated.

The preface asks for criticism and suggestions. One would like to see fuller details given in some of the methods outlined. The scantiness of detail is, of course, compensated by the fact that brevity keeps the size and price of the book under; but, on the other hand, it is sometimes awkward to have to turn up references if out of touch with a large library. At the same time it must be pointed out that the authors have taken great pains to give references to almost all processes described, so that, with access to the originals, the reader is supplied with complete information.

Another point which one would certainly like to see attended to in the next edition is that in the schemes outlined in the form of tables, which appear under each element, it would help immensely if the element which is found were indicated in heavy-faced type, so that one could tell at a glance where the element is in looking through the table

A. J. CHAPMAN.

Popular Oil Geology. By Victor Ziegler. Cloth, small octavo, 150 pages, illustrated. Price 11s. 6d. net. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

In the Magazine for January an appreciative review was given of this book. At the time it was recorded that it deserved a far wider vogue than it was likely to enjoy owing to its being published locally at Golden, Colorado. It is gratifying to learn, therefore, that arrangements have subsequently been made whereby two eminent firms of publishers, in New York and London respectively, have the handling of the book.

Manganese Ores. By A. Harper Curtis. Pamphlet, 118 pages. Price 3s. 6d. net. London: The Imperial Institute.

Tin Ores. By G. M. Davies. Pamphlet, 111 pages. Price 3s. 6d. net. London: The Imperial Institute.

The Far East Rand: Its Reefs, Mines, and Share Values. By W. E. Bleloch. Price 15s. net. For sale by the author at 3, Transvaal Bank Buildings, Fox Street, Johannesburg.

Recovery of Zinc from Low-Grade and Complex Ores. By Dorsey A. Lyon and O. C. Ralston. Bulletin No. 168 of the United States Bureau of Mines.

Tacheometer Tables. By Henry Louis and G. W. Caunt. Price 10s. 6d. net. London: Edward Arnold.

COMPANY REPORTS

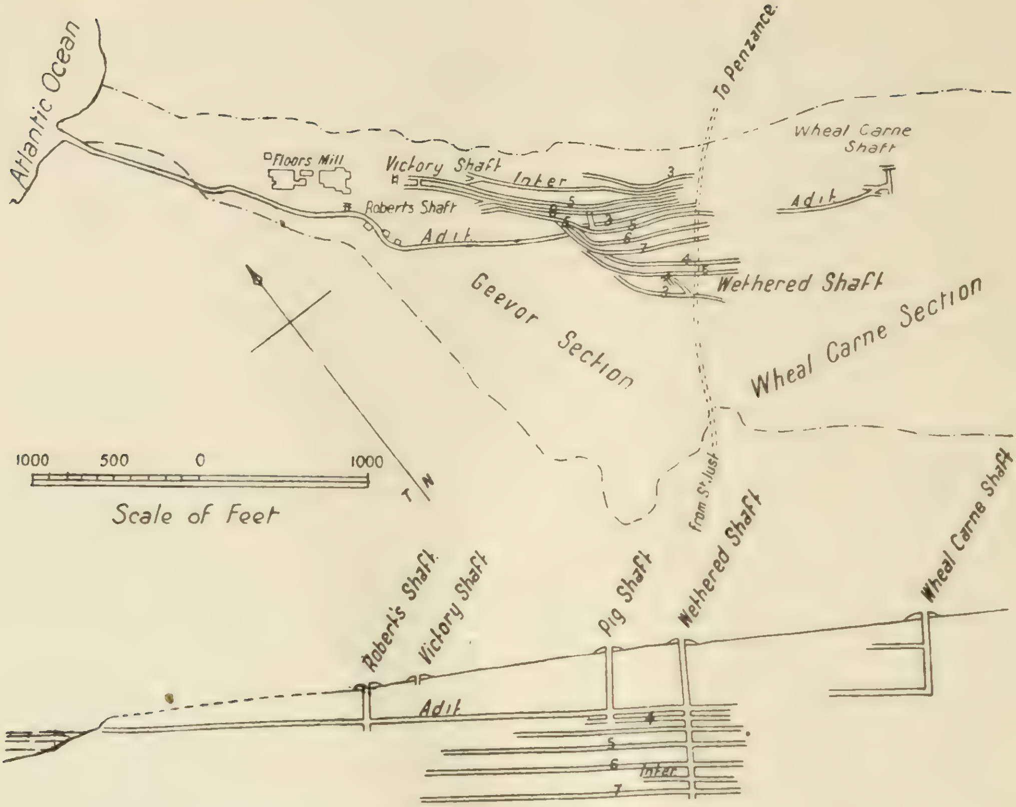
North Anantapur Gold Mines.—This company was formed in 1908 by John Taylor & Sons to acquire property in Madras Presidency, India. Milling commenced in 1910, and the payment of dividends in 1913. The scale of operations and profits has never been large. During the last year or two the developments have been disappointing. The report for the year ended June 30 last shows that 14,200 tons of ore was milled, yielding 10,713 oz. gold, while 15,850 tons of tailing was treated by cyanide for a yield of 977 oz. The total gold realized £49,569. The working profit was £18,445, and after allowances for taxes, depreciation, etc., the divisible profit was £10,618. The preference shares received £5,500, being at the rate of 22½%, and the ordinary shares £4,562, being at the rate of 5%. The reserve is estimated at 11,000 tons, as compared with 20,000 the year before. Development has been disappointing, but further exploration is to be undertaken. The option on the Baragunda copper mine in Chota Nagpur is still held, and exploration is to be commenced.

Geevor Tin Mines.—This company operates a tin mine near St. Just, West Cornwall. Oliver Wethered is chairman, and W. C. Williams is manager. The report for the year ended March 31 last shows that 25,919 tons of ore was raised and sent to the mill, and that the output of tin concentrate was 439 tons, equal to a yield of 37·9 lb. per ton. The receipts from sales were £76,514, the average price obtained being £174 6s. 10d. The net profit was £17,854. Dividends were paid in May and October, 1918, at the rate of 10% each, absorbing £12,000, and another has just been paid, also at the rate of 10%. During the year the capital was increased from £60,000 to £90,000 by the issue of 60,000 new shares of 10s. each, and the dividend now distributed absorbs a proportionately greater amount. As has already been mentioned in the Magazine, the scale of operations is to be still further extended, and 180,000 new shares of 10s. each are now being offered to shareholders at 15s. per share. The present plant has a capacity of 2,000 tons per month, and the new plant authorized at the beginning of this year and now nearly complete will bring the capacity to 4,000 tons. The further expansion now contemplated will bring the capacity to 8,000 tons per month. Mr. Williams estimates the present reserves ready for stoping at 144,000 tons, and reports that they are continually being increased. At the meeting of shareholders held last month, Mr. Wethered announced further discoveries. Reference to these is made by our Camborne correspondent. During the summer, Josiah Paull, of South Crofty, made a record report on Geevor. This we quote herewith, and we also reproduce the plans of the property issued with the directors' report. With regard to the plans, owing to exigencies of space we have not been able to give the full extent of the Wheal Carne section eastward.

Mr. Paull says: "My original report stated that the property is situated at Pendeen and consists of the Geevor property and also the Wheal Carne Sett, the latter situated immediately east of Geevor mine, and containing the continuation of the lodes worked in Geevor, giving a total length along the strike of these lodes of about 8,000 ft. The lodes worked consist of the "Caunter," "South Pig," and "North Pig." Others, such as the "Black" and the "Fern," traverse the property, but have so far not been developed. The Caunter Lode is the larger of the lodes worked, but, though payable in places, samples taken prove it to be very patchy in value. The Pig lodes, though small as compared with the Caunter, are found in sampling to contain almost invariably payable values and in some cases the samples were exceptionally rich in tin. In May, 1918, when my first report was made, the mine was served by the Wethered shaft only, this being equipped with electric three-throw pumps, double winding compartment with one ton capacity self-dumping skips, and ladderway compartment. The ore from the mine was raised by an electric winder. The depth reached in the shaft was 789 ft. from surface, and the extreme length of lateral development was about 2,200 ft., these being still some 6,000 ft. on the strike of the lodes within the boundaries of the property to explore. A cross-cut was being driven at the 7th level from the Wethered shaft toward the North Pig lode, the South Pig lode having been intersected in this cross-cut just previous to my visit. Development of the lodes eastward toward Wheal Carne had been suspended owing to the old workings on the latter, which were supposed to extend to a depth of 600 to 650 ft., being full of water, and it being unknown as to how far these workings extended toward the old boundary between the two mines. I, or my assistants, sampled five of these suspended level ends with the following result by vanning assay:

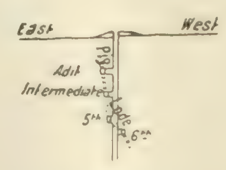
				Lb. black tin per ton	Width in.
4th	level end East on	South Pig	Lode,	16	12
5th	do.		do.	44	14
6th	do.		do.	46	31
6th	do.	North	do.	38	27
6th	do.	Caunter	do.	20	41

"Excellent values were being opened up in the western drives at the 4th, 5th, and 6th levels on the North Pig lode; samples taken from the faces of these drives vanned 132 lb. of black tin to the ton over a width of 24 in. at the 4th level, 336 lb. over 15 in. at the 5th, and 72 lb. over 18 in. at the 6th level. Although narrow, the lode was sufficiently rich to give a good average

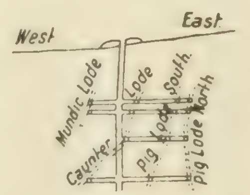


Geevor Tin Mines.—Plan and Longitudinal Section.

value over a stoping width of 3 ft., the lode, with the immediately adjacent granite, being generally easy to mine and admitting of single hand stoping, so that it is an easy matter to keep the stoping width from 2 ft 6 in. to 3 ft. I was much impressed by the fact that stoping operations were being carried out over almost the whole length of the Pig lode developments, thus proving that payable tin values were not confined to short shoots of ore. This was also borne out by various samples taken in the stopes at the different levels. The amount of water encountered has been extremely small, one three-inch pump working two hours daily being sufficient to deal with the water below adit level. Owing to development being restricted eastward, due to Wheal Carne being water-logged, the extension of the levels had been generally westward, and the 5th level end was then some 1,800 ft. from the shaft; and I suggested that a second shaft would greatly facilitate the handling of the ore from the western section of the mine as well as give good ventilation for the further development of this section, and that sooner or later the sinking of this second shaft would become imperative. Surface equipment consisted in May, 1918, of a 100 b.h.p. electric winder, capable of hoisting the 1 ton skips in use 300 ft. per minute, and one 500 cu. ft. per minute capacity air compressor driven by a 75 h.p. motor, there being also a 750 cu. ft. compressor and 75 h.p. motor installed at Wheal Carne, from which air was supplied when necessary. The mill, situated 1,800 ft. to the west of the Wethered shaft, consisted of 4 heads of pneumatic stamps and a good concentra-



Transverse Section showing probable position of North Pig Lode to Victory Shaft.



Transverse Section through Wethered Shaft.

tion plant, composed chiefly of Frue vanners, also Brunton calciner and tin yard for final treatment of concentrates, the whole equipment being driven by a 150 h.p. electric motor. The capacity of the mill was approximately 80 tons of ore per day. There is a fall of about 130 ft between the shaft and mill, and the ore from the mine gravitated first to a rock-breaker station and thence to the mill over an inclined tramroad. Wheal Carne section, as already stated, was full of water at the time of my first inspection, but the main shaft had been cleaned up and retimbered down to the adit level, and surface equipment had been provided for lowering the water and reopening the mine. The object of my first inspection was to obtain my opinion as to whether the property warranted an additional capital outlay to double its output of ore and I had no hesitation in recommending such an outlay, the then reserves of ore and excellent development results being obtained fully warranting this step being taken."

After paying his second visit in August of this year, Mr. Paull wrote: "In the 15 months' interval between my previous and present inspection I find a very considerable amount of work has been accomplished both underground and on surface. The 7th level cross-cut, which had intersected the Caunter lode to the south of the shaft and the South Pig lode to the north at the time of my first inspection, has since been extended to the North Pig, and the latter has been developed east and west for a distance of 834 ft. The Caunter lode has also been driven on for 90 ft. at this level. At the intermediate level between the 6th and 7th main levels the South Pig has been developed for a distance of 497 ft. and the North Pig for 240 ft. Some 269 ft. has also been driven at the 4th, 5th, and 6th levels on one or both of the Pig lodes. Including cross-cutting, just over 3,000 ft. of development has been carried out. As regards tin values, the records of the sampling of the development carried out show the values to be quite equal to or even slightly higher than the average of the mine, which must be very gratifying to the company, especially as the bulk of this development is in the bottom of the mine. Also a new shaft 18 ft. by 6 ft., the Victory, has been started about 1,800 ft. west of the Wethered shaft and close to the mill. This shaft, when down—and it is only some 630 ft. from surface at this point to the present 7th level—should save a considerable tramming cost underground and also in a lesser degree on surface, besides being a tremendous boon in ventilation and making the western section of the mine easily accessible. I consider such a shaft will soon pay for itself in the economies which its sinking and subsequent use will effect. The unwatering of Wheal Carne section of the property has been taken in hand, and the mine is now drained to 282 ft. under the adit level and 462 ft. from surface. The shaft has been cleared and retimbered to this depth, and the levels met with also cleaned out and retimbered where necessary. The present level of the water is now just below the depth of the 3rd or adit level in Geevor section, and it is now proposed to drive on the latter level and communicate with a level at about a corresponding depth in Wheal Carne. The one in Wheal Carne extends west toward Geevor, a distance of 620 ft., leaving rather over 500 ft. of driving to communicate the two. The connection will have the effect of permanently draining Wheal Carne to this depth, and I am of opinion that it will also open up a large section of payable lode, the 3rd level in Geevor being at present in payable ore, and in going through the level in Wheal Carne the lode where unstoped appeared to be generally of a payable nature. From its characteristics I should say this lode is the South Pig. That Wheal Carne produced good tin values during the period it was worked is more or less proved by the fact that the present company has crushed several thousands of tons of waste from its dumps which yielded from 16 to 20 lb. of tin to the ton. The unwatering has so far been done by compressed air, but it is now proposed to install an electrically-driven three-throw pump already on the property and keep the water stationary until communication with Geevor is effected, after which the mine will be further drained and the water delivered to the new and deeper adit level. In the meantime the shaft will be equipped to this level with double skip road and the air compressor will be released for other development work.

"The work of doubling the present mill is well in hand, the building for it has been completed, and the erection of the four additional pneumatic stamps and concentrating plant is nearing completion. The calcining capacity has been doubled and the new calciner put into operation. The inclined tramways from the shaft to the rock-breaker station and mill have been replaced by an aerial ropeway, the rock-breaking being now done at the shaft. This ropeway has a capacity of 200 tons per 8 hours, and besides being more economical should prove a much better method of transport in the winter months, when, owing to the exposed position, it has been found difficult on some of the very wet days to get the men to attend to the tramming of the ore by the old system. Other additions on the surface consist of a new electric power station, which has been built and is now being equipped to meet the additional demands for power which will be made by increasing the output of the mine, new engineers' and smiths' shops, both of which have been equipped with necessary machines and tools, also a new changing house to accommodate a larger underground staff. A new air compressor of a capacity of from 1.200 to 1,500 cu. ft. per minute is now being ordered, which, when available, will admit of the mine being still more rapidly developed.

"From the foregoing it will be seen that the underground developments carried out have been quite up to expectations. The ore reserves have been not only considerably increased, but the tin values have been maintained. I find in the interval since I last reported on the mine that 25,919 tons of ore has passed through the mill and 438 tons of black tin has been sold, showing a recovery of 37·9 lb. to the ton of ore. This is an excellent average. Even allowing for a slightly decreased average, which may result by doubling the output of ore, very satisfactory profits should be made with the present price of tin, although the latter is still low as compared with the increased cost of other products and labour over that of pre-war years. Up to the present barely one-third of the length of the property has been explored, but the sinking of the new shaft and connection with and the unwatering of Wheal Carne should in the comparatively near future render the western and eastern sections of these mines easy for economical development, and from the tin values in both ends of the extent of the already developed ground there is every reason to expect further large tonnages of payable ore will be found in this development, especially westward, as on the parallel lodes in the neighbouring Levant mine the richest ore has been mined where the lodes enter the killas, and the present western ends in Geevor are still some hundreds of feet from the killas contact. Going eastward toward Wheal Carne deeper in the granite, I should not expect the lodes to be so large or highly mineralized, but this should be compensated for to a certain extent by the rising ground going in this direction and the consequently increased backs which will be obtained on the lodes without further sinking, and the present shaft which is being unwatered and repaired should adequately serve this end of the property. In conclusion, I may say that I have no reason to alter the opinion I formed in May last year, that the mine warranted doubling its output; in fact, by the way the mine is now developing and considering its very shallow depth I anticipate further crushing capacity will soon be justified. In any financial arrangements provision should be made for increasing the output to 8,000 tons per month, and for adequately developing the eastern and western ends of the property. The Wheal Carne section is so large that it would justify the formation of another company, but I am fully in accord with your view and that of the manager that the property should be worked as a whole."

Scottish Spitsbergen.—The Scottish Spitsbergen Syndicate, having its headquarters in Edinburgh, was formed in 1909 to take up mineral claims in Spitsbergen acquired by the explorer, Dr. W. S. Bruce. These claims are shown in the accompanying map at B, C, D and E. The claim F has been acquired more recently. The map also shows the claims of the Northern Exploration Company. An expedition went out during the past summer, led by Dr. Bruce and Dr. R. N. Rudmose Brown, with G. W. Tyrrell, of Glasgow University, as geologist. The directors have issued a statement regarding the results of this expedition. We quote herewith Mr. Tyrrell's report on the deposits.

Mr. Tyrrell deals first with the Mount Temple and Klaas Billen Bay region in Central Spitsbergen mainland. Coal was discovered on the south side of Adolf Bay, which is at the head of Klaas Billen Bay, on the first day of landing. At the outcrop the main seam was 27 in. thick, but on driving an adit 70 ft. into the coal it was found to increase in thickness to 30 in. There are two or three smaller seams a few inches in thickness. The early and too optimistic estimate of the amount of coal in this limited area was corrected by later work; and assuming an average workable thickness of 30 in., the amount of coal above sea-level in workable positions is estimated at 560,000 tons, and down to 500 ft. below sea-level at 2,600,000 tons. The first boring was wrongly placed owing to the existence of a large concealed fault in the strata, only discovered later by detailed geological mapping, and also owing to the necessity of starting the boring quickly. Lateness of season prevented a further bore being completed, although there is good reason to believe that it closely approached the coal position. The coal is a coking coal, high in ash, but containing a fair quantity of volatilizable materials. It is suitable for gas manufacture, and possibly for smelting on the ground. It is believed, however, that the most promising field in the Klaas Billen Bay region is that on the north side of Adolf Bay below the De Geer Range. In the Ebba Valley, north of the range, the coal horizon was found at a height of 1,050 ft., below which it has been opened up by Swedish claim-jumpers in one or two small landslipped masses. The section exposed here shows 73½ in. of coal, in seams respectively 10, 4½, 12, 14, and 33 in. in thickness, separated in most cases by a few inches of dirt. An open-cut has also been made by the Swedes on the south side of the De Geer Range, only 200 ft. above sea-level, near an inshore deep-water anchorage. A boring is needed to locate the true position of the coal in this locality, which is considered to be the most promising for mining development. Assuming an average workable thickness of only 48 in. the amount of coal above sea-level in this field is estimated at 14,500,000 tons. The outcrop sample of coal obtained in the Ebba Valley is of precisely the same character as that of the south side of Adolf Bay. The coal horizon was also located in Anser Bay, and near the head of Gips Valley (Gips valley lies between Mt. Temple and Klaas Billen Bay), thus establishing the existence of coal over an area approaching 120 square miles.

Gypsum occurs in practically inexhaustible quantities in this region. There are two main beds of gypsiferous rock, each hundreds of feet in thickness. In one measured section of 452 ft., 263 ft. consisted of solid gypsum. The mineral occurs in several suitable localities at or near sea-level, with good loading and transport conditions. So far as is known this is the only part of Spitsbergen in which this mineral occurs. Many seams are of the highest purity.

The Stor Fiord region, on the east coast of Spitsbergen mainland, includes Barents Island and the northern part of Edge Island. Owing to the very limited time available for the exploration of this part of the Syndicate's properties, no definite conclusions could be arrived at with regard to its mineral resources. There were, however, unmistakable indications of natural gas in at least two localities (Mohn Bay and Barents Island). Bituminous shales of great thickness occur in Barents Island. The oil content of the few and small samples which it was possible to collect was, however, small. The Stor Fiord region may also contain valuable ironstone and coal-beds. The floor of the valley south of Mohn Bay was strewn with blocks of iron-stone and fragments of bright coal.

On the Prince Charles Foreland claims, magnetic iron ore in a bed 24 ft. thick was discovered on the south flank of Mt. Bourrée. According to assay this ore contains on an average 36% of metallic iron, and is of the same nature and quality as the ore now being mined on a large scale in the north of Norway. As the bed caps the top of a small hill almost entirely surrounded by ice, the amount of ore actually in sight is limited; but accumulations of similar ore on three glacial moraines in positions which make it impossible that they could have been supplied from the Mt. Bourrée outcrop, is proof that other beds occur, although probably concealed beneath ice and extensive surface coverings of debris. From the fact that boulders of considerable size containing a higher percentage of metallic iron were found in the moraines, it is obvious that the body of ore *in situ* from which these boulders were derived has yet to be located. Numerous thick and extensive veins and replacement zones of an ore consisting of chalybite (carbonate of iron), hematite (oxide of iron), iron pyrites and copper pyrites, were found in two areas. In some of these veins the iron minerals are dominant, the assayed sample of ore giving about 30% metallic iron. In other veins the pyritic minerals are dominant, an assayed sample giving 2% of copper. These veins contain considerable quantities of low-grade ore in low, easily-accessible localities near good anchorages (Freshwater Bay and Ferrier Haven). The cupriferous vein to which reference is made forms a zone of fragments 30 yards wide at the surface, and extends fully three-quarters of a mile in length.

In view of the many important discoveries which have been made as regards mineral resources in the short period of time available this year, Mr. Tyrrell is strongly of the opinion that steps should be taken to equip on similar lines a further expedition, to be on the ground next season at the earliest possible moment.

Tomboy Gold Mines.—This company was floated in 1899 by the Exploration Company to purchase the Tomboy mine at Telluride, Colorado. Subsequently the Argentine group of claims was acquired and more recently the Montana group, all in the same district. For many years satisfactory profits were made. During the last year or two operations have been impeded by scarcity of labour. The complexity of the sulphide ore in the Argentine property has also caused trouble, and after considerable experiment flotation is being substituted for water-concentration. In this way large reserves should be rendered profitable to treat. The report for the year ended June 30 shows that 155,334 tons of ore was sent to the mill, of which 28,000 tons came from the Argentine and the remainder from the Montana. The yield by amalgamation was worth \$265,796 and by cyanide \$158,222, while the concentrates were worth \$437,712. The accounts show receipts £182,811, and a profit of £14,019. An allowance of £9,877 was made for depreciation, and £18,000 was placed to income-tax account. The year therefore ended with an adverse balance of £13,868. The ore reserve at the Argentine is estimated at 200,000 tons and at the Montana, 300,000 tons. Development has been severely restricted by lack of suitable labour. The flotation plant is expected to start this month.

North Broken Hill.—The report for the half-year ended June 30 shows that 53,984 tons of ore, averaging 15·1% lead, 12·4% zinc, and 8·1 oz. silver per ton, was sent to the mill. The yield was 10,890 tons of lead concentrate, averaging 63·6% lead, 7·5% zinc, and 27·4 oz. silver. The other products of the mill were: 27,123 tons of zinc tailing averaging 15% zinc, 2·9% lead, and 3·6 oz. silver; and 8,121 tons of zinc slime, averaging 15·3% zinc, 2·7% lead, and 2·6 oz. silver. The deliveries of zinc tailing to Amalgamated Zinc was 25,730 tons. The zinc tailing is to be treated in future at a flotation plant now under construction by the company. Operations ceased on May 8 on account of labour disputes. The profit for the half-year was £111,337, out of which £60,000 has been distributed as dividend, being 1s. per £1 share, and £40,000 was placed to new-plant account to provide for the erection of the Minerals Separation flotation plant.

British Broken Hill.—The report for the half-year ended June 30 last shows that 63,099 tons of sulphide ore, averaging 12·4% lead, 11·3% zinc, and 6·9 oz. silver per ton, was raised and sent to the mill. At the lead plant, 9,903 tons of concentrate was produced, averaging 60·7% lead, 7·3% zinc, and 26·4 oz. silver. At the zinc flotation plant 46,443 tons of tailing, averaging 12% zinc, 3·1% lead, and 3 oz. silver, was treated for a yield of 8,040 tons of zinc concentrate, averaging 45% zinc, 9·1% lead, and 10·1 oz. silver. The slime, amounting to 6,753 tons, averaging 6·2% lead, 12·4% zinc, and 5·2 oz. silver, was stacked for future treatment. The amount of carbonate ore raised was 1,953 tons, averaging 23·6% lead and 5·6 oz. silver. The despatches during the half-year were as follows: 1,953 tons of carbonate ore, 9,107 tons of lead concentrate, 1,012 tons of slime lead concentrate, averaging 55·26% lead, 10·83% zinc, and 42·88 oz. silver, and 1,848 tons of zinc concentrate. The profit for the half-year was £65,582, which was carried forward. As readers are aware, operations at all the Broken Hill mines ceased on May 7 last.

Naraguta (Nigeria) Tin Mines.—This company was formed in 1910 to acquire alluvial tin ground at Naraguta, Nigeria. Additional properties have been acquired since, at Karama in the Ninkada district, at Sho near Zungeru, and at Korot. F. N. Best is chairman, C. G. Lush is consulting engineer, and F. O'D. Bourke is manager. The report for the year ended March 31 last shows that shortness of labour, due chiefly to the influenza epidemic, caused a diminution of the output, the produce being 433 tons of tin concentrate, as compared with 517 tons the year before. The income was £66,123, and the profit was £10,318, which was carried forward. An interim dividend for the current year, being at the rate of 5% tax paid and absorbing £8,750, has just been paid. Mr. Bourke's report shows that the output for the year came from the various properties in the following proportions; Naraguta 303 tons, Karama 53 tons, Sho 47 tons, and Korot 30 tons. During the year two prospecting parties have been actively engaged, and prospecting licences have been granted for an area of 18 square miles at Birnin Gwari, Zaria, where gold has been proved in the alluvium.

Huelva Copper & Sulphur.—This company was formed in 1903 to operate the Monte Romero and other pyrites mines in the south of Spain, previously worked by the Huelva Central Copper Mining Co. Under the management of Henry F. Collins, a smelting plant was erected. The report for the year ended June 30 last shows that 61,996 tons of ore was raised, and that this, together with 7,625 tons of purchased high grade ore and precipitate, was sent to the smelter, where 1,981 tons of copper was produced. The accounts show receipts from the sale of copper, £218,611, and a loss of £4,227. The reserve of smelting ore was estimated at 86,000 tons and of cementation ore 19,000 tons.

Gaika Gold.—This company was formed in 1902 by the Rhodesian Exploration & Development Co. to acquire a gold mine near the Globe & Phœnix, in the Sebakwe district of Rhodesia. The control passed to the Gold Fields Rhodesian Development Co. in 1912. Milling started in 1905, and dividends have been paid since 1911. The report for the year ended June 30 last shows that 36,789 tons of ore was milled, yielding 15,756 oz. of gold, worth £66,860. The net profit was £13,624, and after £5,059 was allowed for income tax, £8,565 remained as divisible profit. The shareholders received £8,204, the dividend being at the rate of 3%. Further development on the new shoot recently opened on the 5th level has proved disappointing. Other development undertaken during the year was on the 3rd level from No. 16 shaft. Here a shoot of ore has been found on the Rubble reef extending 120 ft. and assaying 35·5 dwt. over 3 ft. A winze from this level has been sunk 45 ft. in which the ore averages 48·5 dwt. over 37 in. On the 2nd level a shoot of ore has been proved 100 ft. averaging 32 dwt. over 41 in. The ore reserve at June 30 was estimated at 60,000 tons averaging 12·4 dwt., as compared with 80,000 tons averaging 13·1 dwt. the year before.

Prestea Block A.—The company was formed in 1903 by Edmund Davis to acquire gold-mining properties in West Africa from the Prestea and Appantoo companies. Additional property was subsequently acquired from the Appantoo, and in 1911 the property of the parent company, the Prestea, was absorbed. Milling commenced in 1906, but was suspended from 1909 to 1911 pending further development. The capital has been rearranged and increased on several occasions, and loans have also been raised. The loan from the Central Mining & Investment Corporation has been repaid. The report for the year 1918 shows that 190,906 tons of ore was treated, averaging 39s. 4d. per ton, yielding gold worth £322,350 or 33s. 9d. per ton. The working cost was £308,647, or 32s. 4d. per ton. After the allowance of £29,521 for depreciation, and other smaller items, the year ended with an adverse balance of £18,470. The ore reserve at December 31 was estimated at 427,325 tons averaging 38s. 4d. per ton, as compared with 527,669 tons averaging 39s. 4d. the year before. The fall in these figures is due to the poor results on the 10th level. Recent advices are more encouraging as to the results on the 11th level.

Middleburg Steam Coal & Coke.—This company was formed in 1902 to acquire coal lands in the Middelburg district of the Transvaal. The report for the year ended June 30 last shows that 281,666 tons of coal was raised, as compared with 274,802 tons the year before. The profit was £11,701, out of which £3,245 was paid as preference dividend, being at the rate of 5%, and £7,491 as ordinary dividend, being at the rate of 7½%. Additional land has been acquired, and the plant has been extended and improved with a view to increased output.

Weardale Lead.—This company was formed in 1883 to work a group of lead mines near the head of the river Wear in Durham. The galena is found in the Carboniferous Limestone, and is associated with fluor-spar. An article describing the mines, written by Professor Henry Louis, was published in the Magazine for January, 1917. The report for the year ended September 30 shows that the company ceased smelting operations in May, and thereafter sold the lead concentrate. The output of lead concentrate was 2,837 tons. Of this, 1,617 tons was smelted, together with 532 tons of purchased concentrate. The yield was 1,869 tons of pig lead, which was sold at the average price of £31. 8s. 6d. per ton. Since May, 1,220 tons of concentrate has been sold, at the average price of £15. 6s. 2d. per ton. The lead concentrate produced during the year came chiefly from the Boltsburn mine, but the Stanhopeburn ore yielded 215 tons and Sedling ore 21 tons. The output of fluor-spar was 6,975 tons at Stanhopeburn, 3,950 tons at Sedling, and 774 tons at Boltsburn. The accounts for the year show a net profit, after provision of income tax, of £7,421, out of which £7,344 has been paid as dividend, being at the rate of 7½% tax paid. Labour troubles and uncertainty as to the price of lead and the Government's intentions have been adverse factors in the situation.

Frontino & Bolivia.—This company was formed in 1864 to work gold mines in Colombia, South America. It was reconstructed in 1886 and in 1911, on the latter occasion Pellew-Harvey & Co. becoming the consulting engineers. The report for the year ended June 30 last shows that 29,020 tons of ore from the Silencio mine was treated by amalgamation and cyanide, for a yield of 23,564 oz. of gold and 15,726 oz. of silver. Other operations produced 394 oz. of gold. The accounts show an income of £106,473, and a profit of £18,309, out of which £4,513 has been distributed as debenture interest, £2,339 as dividend on the preference shares, and £10,500 on the ordinary shares, the latter being at the rate of 7½%. The ore reserve is estimated at 56,100 tons averaging 17 dwt. per ton, as compared with 58,500 tons averaging 18 dwt. the year before. The company is contemplating the reopening of several other properties in the neighbourhood, in particular the Marmajito and Cogote mines. These properties were transferred to a subsidiary in 1916. Working capital to the extent of £19,000 is now being subscribed by the issue of preference shares in the subsidiary. Of these the Frontino & Bolivia company will subscribe for half.